

FACULTY OF EDUCATION



EXPLORING FOUNDATION PHASE LEARNERS' UNDERSTANDING OF A HEALTHY ENVIRONMENT THROUGH CONCEPTUAL CHANGE AND COLLATERAL LEARNING STRATEGIES

BY

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ORIGINALITY DECLARATION

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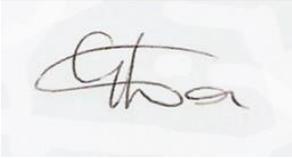
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DEDICATION

To my late son and daughter, Munalula and Mwangala, respectively.

ABSTRACT

This study was carried out in the King Cetshwayo District of the Province of KwaZulu Natal, South Africa. Four schools offering Foundation Phase education were randomly selected for the study from the accessible population. Altogether, a total of three hundred and twenty-eight learners participated in the study from Nseleni, Richards Bay and eSikhaleni education circuits.

This study aimed to contribute to our understanding of how Foundation Phase (Elementary School) learners conceptualised a healthy environment, and whether or not instruction based on the classical cognitive conflict conceptual change model would differ from an approach based on collateral learning theory in educating grade three learners about a healthy environment. Specifically, the study set out to answer three research questions, namely: (a) What conceptions do grade three learners have of the construct of a healthy environment? (b) What explanations lie behind the learners' conceptions of a healthy environment? and (c) Will there be a statistically significant difference in learner achievement between those taught through a cognitive conflict-based conceptual change approach versus those taught through an instructional approach based on the collateral learning theory?

The theoretical basis of this study was built upon literature which pointed to the imminent threat to Planet Earth, seen against the devastating effects of human actions in the name of civilisation. Accordingly, elements from the *cognitive conflict-based* perspective of *conceptual change* and the *collateral learning theory* were integrated with Vygotsky's theory of the Zone of Proximal Development to consummate a conceptual framework for the study. In the view of the researcher, the conceptualisation and development of the conceptual framework of this study was one of her significant outputs.

The research methodology was situated within the mixed methods research paradigm, meaning that both qualitative and quantitative data were collected. As a mixed methods research project, there were two designs applied. The first was a Case Study design, formulated to address the first two research questions, and utilising a test and interviews.

The second research design was the Non-Equivalent Groups quasi-experimental research design, which was directed towards addressing the third research question. Simple random sampling was used to select the four participating schools from the education Circuits that participated in this study.

Data were collected through individually-based and focus group interviews, as well as a pre-test, which also served as a post-test. The interviews were used to explore the grade three learners' understanding of a healthy environment and elicit explanations about their answers in the hope of revealing the underlying reasoning for their answers concerning a healthy environment. Permission was requested and obtained to have all the interviews voice-recorded so that the interviewers could focus on the conversations with the learners rather than, for instance, on note-taking. The test was used to establish the baseline knowledge that the learners had about a healthy environment, as well as estimate their gains following the two interventions. The written test was administered in the usual way as class tests.

Qualitative data arising from individual and focus group interviews were analysed based on the hermeneutical approach – the first stage of which involved reading through all the transcripts of the learner responses and creating categories of description to identify emerging themes. This entailed finding patterns from which the themes and conceptual categories were constructed. In a reiterative process, the recurring themes and conceptual categories were progressively reduced in number by combining conceptually similar ones, resulting in a consolidated, fewer numbers of categories of descriptions. Quantitative data were analysed statistically using the Statistical Product and Service Solutions (SPSS). The analysis involved a comparison of the means as a result of the two interventions. In this regard, both the Analysis of Variance (ANOVA) and the t-test statistic were used.

On the first research question, the majority of the participants demonstrated a good understanding of the term 'environment' in line with the espoused content of the Foundation Phase curriculum. On the definition of pollution, two categories of description emerged – that is, a view of pollution as some form or other of 'contamination', and pollution characterised in terms of its consequences or negative effects on the environment, people,

animals and plants. On the whole, the learners demonstrated an acceptable level of understanding of the concept of pollution. Furthermore, the results showed that the learners had a good grasp of the concepts of *safe drinking water*; *unsafe drinking water*; *wasting water*; *using water wisely*; *land/soil, air, water* and *noise pollution*, well as the 3R's of *recycling, re-using* and *reducing*. However, some mis- and/or alternative conceptions were noted. Overall, the general picture that emerged was that the grade three learners' understanding of a healthy environment was in line with the expectations of the school curriculum at the Foundation Phase level.

On the second research question the learners appeared to experience difficulty with the notion of recycling. On pollution, there was sufficient evidence that the learners made the connections between the respective photographic materials used and water, land/soil, air, and noise pollution. In addition, most learners gave explanations concerning how these types of pollution affected living organisms which depended on the particular environment. Furthermore, the learners easily distinguished between safe and unsafe drinking water, and gave satisfactory explanations about the adverse effects of drinking polluted water. However, it should also be mentioned that a few misconceptions also emerged from some of their explanations. These included the notions that one could catch TB from drinking dirty water, and that drinking clean water resulted in someone having enough blood. From learner explanations, the concept of re-using was partially understood. Overall, however, it should be stated that the learners had a good idea of the selected environmental concepts as prescribed by the Foundation Phase curriculum.

On the third research question, although some gains had been made by both groups, there was no statistically significant difference between the two posttest mean scores. However, using the pretest scores as baseline, the collateral learning group had performed statistically significantly beyond the pretest, suggesting that there was some merit in thinking that collateral learning could be a productive approach to use in South African schools. The posttest mean score of the cognitive conflict-based conceptual change group was not significantly different from the pre-test mean score. This result suggests that more research is still needed to give clarity to this matter.

Within the constraints of the study, the researcher is satisfied that much was achieved, and that the results reported in this study will go a long way in serving as baseline data for future research. The thesis ends with some recommendations in respect of both classroom practice and further research.

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CHAPTER ONE

RESEARCH ORIENTATION

1.1 INTRODUCTION

Research has revealed that by the time children enrol in school, they already have their own ideas about many Life Science concepts (Aikenhead, 1996; Inagaki and Hatano, 2006; Prokop, Prokop, Tunnicliffe and Diran, 2007; Jonassen, 2009; Hargreaves, Lieberman, Fullan, and Hopkins, 2017). In this respect, Inagaki and Hatano (2006: 177) point out that children as young as 5 years of age “possess a theory-like knowledge system that can be called *naïve biology*, which involves a set of causal devices enabling children to offer coherent predictions for biological phenomena.” In similar vein, Prokop et al. (2007: 62) report that “ideas about the biological world are developed in early childhood prior to children reaching school age.” In concurrence, Coetzee and Imenda (2012: 2) aver that “learners come to science lessons with a wide range of some already strongly held ideas, which may differ from the theories the educator may wish to develop.”

Many terms have been used in literature to characterise these ideas – such as, naïve concepts, intuitive ideas, common-sense ideas, misconceptions, pre-conceptions, alternative concepts, and so on. These ideas are built up over time from the day-to-day interactions of the children with their environment. As Jonassen (2009: 20) points out, theory making is just part of human development in the sense that “from an early age, humans naturally build simplified and intuitive personal theories to explain their world.” According to Driver and Head (1986), the origins of alternative conceptions bear their roots in the individual’s previous experience and observation, language, cultural influence, and the way teachers and textbooks present information. However, in many instances, the ideas held by children are at variance with those espoused by the school curriculum. The difficulty with this is that, once formed, these alternative conceptions influence the children’s future learning (Driver, 1983).

The discrepancy between the children's home-based ideas and those of the school curriculum points to the need for teachers who are able to nurture these children towards the intended educational goals. For this reason, Akerson et al. (2000: 364) opine that "in the absence of a teacher who understands and uses knowledge of children's ideas to inform instruction, children are unlikely to develop their ideas towards scientific understanding." Unfortunately, many studies have revealed that the alternative conceptions that children have about some science concepts are resistance to change, and the children hold on to them tenaciously even after formal instruction has been completed (Driver, 1983; Akerson et al., 2000; Zhou, 2012).

In the Foundation Phase, science is taught as part of the Life Skills curriculum (Department of Basic Education [DBE], 2011). Overall, the Grade R-3 Life Skills subject is seen as being "central to the holistic development of learners" within the Foundation Phase curriculum, and "is concerned with the social, personal, intellectual, emotional and physical growth of learners, and with the way in which these are integrated" (DBE, 2011: 8). The Department further explains the centrality of Life Skills within the Foundation Phase curriculum as follows:

In the Curriculum and Assessment Policy Statement (CAPS) the subject Life Skills in Foundation Phase (Grades R-3) has been organised into four study areas: Beginning Knowledge, Personal and Social Well-being, Creative Arts and Physical Education. Life Skills has been organised in this way in order to ensure that the foundational skills, values and concepts of early childhood development and of the subjects offered in Grades 4 - 12 are taught and developed in Grades R-3. Beginning Knowledge and Personal and Social Well-being are integrated in the topics. Life Skills is a cross cutting subject that should support and strengthen the teaching of the other core Foundation Phase subjects namely Languages (Home and First Additional) and Mathematics. (DBE, 2011: 8)

In particular, natural science and technology are presented under the Beginning Knowledge and Personal and Social Well-being strand of the Life Skills curriculum. More specifically, the topics that are to be covered under this curriculum strand include: conservation, cause and effect, place, adaptation, relationships and interdependence, diversity and individuality, life and living, energy and change, matter and materials; planet earth and beyond; Scientific process skills; the

process of enquiry which involves observing, comparing, classifying, measuring, experimenting, and communicating – as well as the Technological process skills of investigate, design, make, evaluate, communicate. (DBE, 2011: 8). The other science-related topics covered in the Foundation Phase (Grades R to 3) are nutrition, diseases (including HIV/AIDS), and environmental health (p. 9).

With specific reference to environmental health, the DBE (2011) prescribes the following topics for grade R: (a) the importance of a clean environment, (b) ways in which people pollute the environment, and (c) the importance of recycling (p. 20). These topics are further developed and expanded in grade 3, with a focus on (a) recycling: exploring what happens to our waste, re-using (things that can be used again), recycling (used things that can be made into something new), reducing (using less), things that cannot be recycled, recycling at home and at school, making compost out of things that rot, and re-using water (p. 55); and (b) pollution: what pollution is, different types of pollution, effects of pollution on people, and effects of pollution on the environment (p. 56).

Thus, although natural science and technology emerge as a combined subject in the Intermediate Phase (Grades 4 to 6), it is important that whatever science topics are introduced within the Foundation Phase are taught well. Part of teaching these topics well includes bearing in mind the prior knowledge and understanding (misunderstanding?) that the learners already have about these topics. Accordingly, this study set out to find out some of the prior knowledge and understanding which learners in the Foundation Phase have, as well as investigate the best possible ways of teaching some of the topics listed above.

1.2 LITERATURE REVIEW

In science, it has been widely reported that children come to school already having their own ideas about many biology concepts (Prokop, et al., 2007; Kubiak and Prokop, 2007; Patrick and Tunnicliffe, 2011; Allen, 2015; Prokop, Fančovičová and Krajčovičová, 2015). Unfortunately, many of these ideas express knowledge views alternative to the ideas espoused by the school curriculum. Over the past few decades, considerable effort has been made to establish

the possible origins of the alternative conceptions exhibited by learners. However, as Wenning (2008: 12) points out, “the origin of a given alternative conception is often difficult if not impossible to determine. Misunderstanding, miscommunication, miseducation, and even a misapplication of well-established physical principles lead to the formation of alternative conceptions.” Nonetheless, it is presently safe to say that “many science teachers are aware of the existence of alternative conceptions – notions held by students that are contrary to those generally accepted by mainstream scientists” (Wenning, 2008: 11), and also that these “preconceptions are often at odds with scientific ideas and continue to persist following traditional instruction” (Zhou, 2012: 112).

1.2.1 The Cognitive Conflict Model of Conceptual Change

Over the past few decades, the ‘discrepant’ notions that children have in relation to the espoused curriculum content have posed quite significant challenges to science teachers. In attempting to ameliorate these discrepancies many approaches have been attempted, but what has been particularly puzzling – and to some extent disturbing, has been the observation that “preconceptions are apparently changed in school settings but may quickly reassert themselves in the broader context of daily life” (Zhou, 2012: 113). As such, there has not been a “clear distinction about whether these changes reflected students’ profound change in thinking or a process of simply following what teachers instructed in some particular academic contexts, such as exams” (Zhou, 2012: 113).

With regard to pedagogies directed at ameliorating alternative conceptions, there have been several general approaches conceptualised and implemented over the past few decades. These include a general class of strategies which appear to be inspired by the Piagetian perspective of learning based on the notion of disequilibrium. The strategies have had in common “the requirement that students encounter phenomena that run counter to their existing beliefs” (Wenning, 2008: 14). As Wenning (2008: 14) reports, by thrusting learners into “a state of intellectual disequilibrium or cognitive conflict” it was envisaged that such learners would become “aware of the conflict between what they believe to be correct based on prior experiences and know to be correct based on more recent experience.” Accordingly, the learners

would be forced to “confront and resolve their conflicting perspectives” in favour of what they have learnt from the most recent school experiences. According to Wenning (2008: 12), this general class of interventions include: learning cycles, conceptual change theory of Posner, et al., bridging analogies, microcomputer-based laboratory experiences, disequilibrium techniques, an inquiry approach coupled with concept substitution strategies, metaconceptual teaching on inducing a particularly problematic aspect of the conceptual changes, and a teaching model developed by Thomaz et al., 1995.

Typically, these instructional approaches involved an ‘elicit, confront and resolve’ strategy, whereby the teacher:

... first elicits a response (prediction about what will happen or an indication of agreement or disagreement with a given statement) from students, forcing them to commit to an answer in relation to a specific situation. Next, the students confront a situation that challenges their beliefs and answers, typically in an experiment that the students perform. During this second phase, if the students were incorrect in their prediction, they experience cognitive dissonance when confronting the conflict between prediction and experience. Students quickly come to realize the need for a new understanding about the concept under consideration, and are motivated to resolve the conflict with teacher assistance in phase three. (Wenning, 2008: 14).

However, it has been reported that this *Elicit-Confront-Resolve* approach of overcoming alternative conceptions has not always been an effective strategy (Wenning, 2008: 14). Arguing that “a poorly understood *Elicit-Confront-Resolve* approach fails to make a substantial lasting difference in the area of alternative conceptions”, Wenning surmises that a five-step model, with two additional steps, would work better. He posits that the *Elicit-Confront-Resolve* model has been ineffective “because it fails to clearly *identify* the existence of the alternative conception to students and fails to *reinforce* student learning in the area of the alternative conception” (Wenning, 2008: 15). As such, he proposes the *Elicit-Confront-Identify-Resolve-Reinforce* (ECIRR) model, with an emphasis on identifying the alternative conceptions and reinforcing conceptual change in ways that are specific to the clearly identified alternative conception. So far, there is not enough empirical evidence on the efficacy of the ECIRR approach.

Overall, the apparent ineffectiveness of these teaching strategies was attributed to the observation that, most if not all, were influenced by Posner et al.'s *replacement* model of conceptual change. This model was based on the notion that “students’ dissatisfaction with the old conception and the intelligibility, plausibility, and fruitfulness of the new conception” would compel them to abandon their original conceptions in favour of the school-inspired one (Zhou, 2012: 112). As Zhou further elaborates:

The purpose of science teaching was therefore assumed to be a replacement of students’ less acceptable conceptions by more sophisticated scientific concepts capable of accounting for phenomena where preconceptions were unable to do so. This replacement was called conceptual change. (p. 112).

Zhou observes that the replacement model neglected one crucial aspect attendant to human learning – that is, that learning is undergirded not only by rational but also irrational properties. As Zhou (2012: 113) points out “the assumption that students approach their classroom learning with a rational goal of making sense of the information and coordinating it with their prior conceptions may not be accurate.” Thus, Zhou questions the assumption that learners approach learning only with a rational goal in mind. Instead, Zhou (2012: 113) points out that “students have many social goals in the school context besides academic understanding such as making friends, impressing peers, or pleasing instructors ... which can turn them away from any in-depth intellectual engagement with the curriculum content ... [that] students may passively face conceptual discrepancy by just memorizing the scientific concepts without understanding them.” As such, Zhou surmises as follows:

The normative goal theory has made this point very clear since it states that students with the goal of mastery learning are more engaged in deeper cognitive processing and tend to use more sophisticated cognitive strategies. In contrast, students with performance-orientated goals more often use surface processing and have less cognitive engagement ... [that] there are numerous theoretical articulations suggesting that an individual’s

learning in the classroom is not isolated, but greatly influenced by interactions with others.

For its neglect of other human aspects of learning, the replacement model is referred to by some researchers as a “cold model.” The detractors of this model find it and its related instructional strategies for being solely “a description of the role of students’ intentions in bringing about change and focusing “mainly on what teachers could do to manipulate the context to support learners’ knowledge restructuring.” (Zhou, 2012: 114). Overall, it has been argued that “the conceptual change pedagogy was oversimplified as a matter of placing students in circumstances that highlight points of conflict ... [that] cognitive conflict is unfortunately often insufficient to induce change” (Zhou, 2012: 114).

1.2.2 Conceptual Change and Motivation

In response to the criticisms concerning the cognitive conflict model of conceptual change, Dole and Sinatra (in Zhou, 2012: 114) came up with the Cognitive Reconstruction of Knowledge Model (CRKM), which “incorporated motivational constructs into the complexity of conceptual change learning.” In terms of this model, motivational factors “refer to a learner’s interest, emotional involvement, self-efficacy, value, need for cognition, as well as the social context that supports or undermines his or her motivation. Message characteristics refer to the features of the instructional content or persuasive discourse designed to promote conceptual change, which can be described by using adjectives such as comprehensible, coherent, plausible, and rhetorically compelling” (Zhou, 2012: 114). Explaining this model, Zhou (2012: 114) states as follows:

The CRKM describes how learner and message characteristics interact, leading to a degree of engagement with the new concept. The learner characteristics entail existing knowledge and motivational factors. The strength and coherence of a learner’s existing knowledge and his or her commitment to it are assumed to influence the likelihood of conceptual change ... It is the interaction of the existing knowledge, instructional message, and individual motivational factors that is assumed to create a space for knowledge reconstruction.

1.2.3 Conceptual Change in the Context of Multiple Realities

According to Monteiro (2015: i) research acknowledges that if students are to be successful in science, “they must learn to navigate and cross-cultural borders that exist between their own cultures and the subculture of science.” The notion of cultural border crossing is based on the day-to-day practice of people appealing to epistemologically different aspects of their lives. Accordingly, Costa (in Monteiro, 2015: 7) developed a typology consisting of five categories of students with regard to how they navigate “transitions between their worlds of family, peers, and school and the connections between these transitions and the students’ success in the science classroom.” Depending on the category a student falls under, the challenge of crossing over to the sub-culture of school science from the traditional and / or everyday culture(s) may be smooth or quite daunting – resulting in the learners performing quite differently in science. The metaphor of border crossing has been used to illustrate students’ cultural transitioning from their traditional and everyday cultures, on one hand, to the school science, on another (Aikenhead, 1996; Aikenhead and Jegede, 1999). Zhou explains the phenomenon of border crossing as follows:

This metaphor announces that people must cross borders as they move from one culture to another. It reflects the uneasiness and struggles that students have to face when coming to the science classroom. It also signals that students may have different experiences when they cross the border due to their varying cultural backgrounds and personality factors.

Table 1.1 presents a summary of Costa’s five typologies, their descriptions and the likely state of transitioning across the traditional/everyday culture to the school science sub-culture.

Table 1.1 Costa’s typologies of learners with regard to border crossing

Typology	Description	State of Transitioning
Potential scientists	Worlds of family and friends are congruent with worlds of both school and science	Transitions are smooth
Other smart kids	Worlds of family and friends are congruent with world of school but inconsistent with	Transitions are manageable

	world of science	
I don't know students	Worlds of family and friends are inconsistent with worlds of both school and science	Transitions tend to be hazardous
Outsiders	Worlds of family and friends are discordant with worlds of both school and science	Transitions are virtually impossible
Inside outsiders	worlds of family and friends are irreconcilable with world of school but potentially compatible with world of science	Transitions are frustratingly difficult

Source: Constructed by the writer from textual information

In interpreting these categories, Aikenhead and Jegede (1999: 184) point out that whereas “the first four categories represent degrees of ease at crossing cultural borders into school science” the fifth one “arose from abject discrimination against some students by the school.”

In reflecting on these typologies Aikenhead and Jegede (1999) surmised that:

... cultural transitions are smooth when the cultures of family and science are congruent, transitions are manageable when the cultures are somewhat different, transitions tend to be hazardous when the cultures are diverse, and transitions are virtually impossible when the cultures are highly discordant. The metaphor of border crossing does provide a tool to discuss the difficulty students have in learning science; however it seems to have little power explaining the phenomena mentioned in the following section. (Zhou, 2012: 118).

Thus, rather than talk about overcoming mis- or alternative conceptions which learners bring to the classroom, Aikenhead and Jegede (1999) propose that teachers (a) recognize Western science as a distinct cultural entity itself; (b) acknowledge the cultural border crossings that most students experience to varying degrees when they move from their life-worlds into the world of school science, and therefore, acknowledge that learning science is a cross-cultural event for most students; (c) consider the various ways students deal with cognitive conflicts arising from culture clashes, and use collateral learning theory to make sense out of these conflicts; and (d) help students negotiate their border crossings and help them resolve any cultural conflicts.

1.2.4 Conceptual Change versus Cognitive Style

In his study involving Zulu primary school children, Imenda (2015: 61) reports about “the importance of context in Zulu children’s understanding of their world, and concept formation, generally.” Imenda explains his findings as follows:

... the primacy of context exhibited by the respondents within the aegis of a holistic cognitive style has been a very significant outcome of this research. It is, therefore, important to understand how cognitive style differences affect sense making for the respective types of thinkers. Understanding how this takes place among people of different cognitive styles would improve instruction.

The question of cognitive style is made more important as an aspect for immediate consideration against the revelations that, whereas most school curricula of developing countries are based on the analytic cognitive learning style, the dominant learning style of most indigenous communities is, in fact, holistic (Lin, Lyn, Wei, Tan and Yeo, 2013). Briefly, explained, the analytic cognitive learning style involves understanding a system by thinking about its parts and how the individual parts work together to produce larger-scale effects, whereas the holistic cognitive learning style refers to an inclination to understand a system by sensing its large-scale patterns and reacting to them. In this regard, Lin, et al. (2013: 4) report that it has generally long been established “that individuals of individualistic cultures tend to think analytically when engaging in cognitive activities whilst individuals of collectivistic cultures engage in holistic thinking.” It is for this reason that it appears justified to suggest that due consideration be given to the issue of conceptual change against the backdrop of these two cognitive learning styles, and the implications they pose for how the affected learn.

The theory of collateral learning states that learners can hold onto two or more conflicting world views simultaneously in their long-term memories (Jegede and Aikenhead, 1999: 51). In the lived experiences of many African people, for instance, it is common to see people hold two wedding ceremonies – a white wedding, following Christian ceremonial etiquettes and a traditional wedding, where the bride is introduced to the groom’s family members, including ancestors. This theory, therefore, espouses that there is nothing wrong with holding onto more than one worldview and transition between them whenever necessary. In total, Jegede (1995) describes four types of collateral learning: (a) parallel, (b) simultaneous, (c) dependent, and (d)

secured. Jegede immediately points out, however, that these typologies are not separate but points along a continuum. The definitions of these collateral learning types, as well as the differences among them, will be presented in chapter two.

1.3 STATEMENT OF THE PROBLEM

The literature reviewed above has revealed three main areas of contestation which are important to this study. The first one relates to the ideas which learners bring to the school curriculum from both home and their social circles. The way these ideas should be handled in relation to the espoused school knowledge, especially where there is cognitive dissonance between the two, is of particular importance to both the learners and school authorities. With regard to the literature on conceptual change pedagogies, it has been noted that strategies based on throwing learners into a state of intellectual disequilibrium or cognitive conflict does not necessarily lead to permanent or long-term conceptual changes. This has led to the view that learners should be encouraged to see their own out-of-school sub-culture as representing authentic knowledge, but that there are also alternative knowledges which may be equally, or even more, important. As such, learners should be allowed “to navigate and cross-cultural borders that exist between their own cultures and the subculture of science” (Monteiro, 2015: i).

The third dimension relates to the dichotomy of analytic versus the holistic cognitive learning styles. Mainly due to colonialism Western countries have had a huge influence on the school curricula of many countries across the developing world (Owuor, 2007; Wane, 2013; Shizha, 2014). Accordingly, most African school curricula are Western-orientated. Not surprising, therefore, one finds that most school curricula valorise analytic knowledge and skills above other types of knowledge and skills, even in societies which typically have holistic cognitive styles – such as most indigenous African cultures. It is possible that because of the analytic orientation of the school curricula, most African learners fail to capitalize on their holistic cognitive asset. This could suggest a situation of ‘double jeopardy’ whereby apart from (and perhaps because of) coming to school with knowledge conceptions which may be ‘alternative’ to the espoused school knowledge, they also have a cognitive style that is incongruent to the one needed by the school curriculum. The question that arises is, therefore, would it not be easier for indigenous African learners to learn using a holistic cognitive approach, rather than an analytic approach?

The Department of Basic Education [DBE] (2011: 12) defines ‘science’ as “a systematic way of looking for explanations and connecting up the ideas we have.” The question that immediately arises is, “Which ideas?” From research we are aware that learners come to school with their own ideas, many of which are inconsistent with those espoused by the school curriculum (Allen, 2015; Prokop, et al., 2015). Thus, as an exploratory study, this research sought to document the ideas which Grade 3 learners had about the notion of a healthy environment; what explanations the learners had for these ideas; and the degree of alignment of these ideas vis-à-vis the espoused school curriculum. As pointed out above (Owuor, 2007; Wane, 2013; Shizha, 2014), the challenge is that should the ideas children bring to the classroom be cognitively and contextually at variance with those espoused in the school curriculum, this could be a source of insurmountable learning barriers for some learners.

1.4 AIM OF THE STUDY

The aim of this study was to explore grade 3 learners’ understanding of a healthy environment and compare the effectiveness of teaching approaches based on the conceptual change perspective versus collateral learning theory, in helping grade 3 learners to achieve espoused learning outcomes.

1.5 RESEARCH QUESTIONS

In order to give effect to the above aim, the study addressed the following research questions:

- 1.5.1 What conceptions do grade three learners have of the construct of a healthy environment?
- 1.5.2 What explanations lie behind the learners’ conceptions of a healthy environment?
- 1.5.3 Will there be a statistically significant difference in learner achievement between those taught through a cognitive conflict-based conceptual change approach versus those taught through an instructional approach based on Collateral Learning Theory?

1.6 RESEARCH OBJECTIVES

The above research questions translated themselves into the following research objectives:

- 1.6.1 To find out grade three learners’ understanding of a healthy environment.

1.6.2 To explore the explanations which lie behind grade three learners' understanding of a healthy environment.

1.6.3 To find out whether or not there is a statistically significant difference in learner performance between those taught through a cognitive conflict-based conceptual change model versus those using an instructional approach based on collateral learning theory.

1.7 RESEARCH HYPOTHESIS

The first two research questions were exploratory in nature, so the data collected were largely qualitative. Consequently, there was no statistical testing of hypotheses involved. However, the third research question required statistical testing. Therefore, one *a priori* research hypothesis is hereby presented.

H₀: There is no significant difference in learner performance between those taught through a conceptual change model versus those using an approach based on the collateral learning theory.

H₁: There will be a significant difference in learner performance between those taught through a conceptual change model versus those using an approach based on the collateral learning theory.

Later, after analysing the results from the *a priori* hypothesis, two *a posteriori* hypotheses were formulated and tested. This information is presented in chapter four.

1.8 MOTIVATION OF THE STUDY

The challenges of ensuring that learners get the best learning experience at school despite their home or cultural backgrounds is an on-going paradox for most teachers, especially with respect to science teaching. This is so because most learners and teachers find the content and ways of science to be far removed from their day-to-day experiences. Classroom diversity, which has

also become a reality for most classrooms currently, has intensified a search for solutions insofar as dealing with the different world perspectives which learners bring to the classrooms is concerned. Thus, to the extent that this study seeks to find solutions to the challenges of how best to address the knowledge that learners bring to the classroom holds prospects for making a significant contribution to both knowledge and classroom practice. Furthermore, conducting the study at the Foundation Phase level should also give this study added benefits to both teachers and learners. Many attitudes and conceptual orientations are formed early in a child's life so, hopefully, by virtue of participating in this study, the learners concerned will form positive attitudes and scientifically acceptable conceptions about the environment, which is the main topic under investigation in this study.

1.9 RESEARCH METHODS

The various aspects of the research methods to be followed in this study are briefly described below under various sub-headings which include research paradigm, research design, study locales, target population, sampling technique and research sample, research instruments, data collection procedures as well as data analysis approaches and techniques.

1.9.1 Research Paradigm

This study followed a mixed methods approach, meaning that both qualitative and quantitative data were collected. The Quantitative and Qualitative research paradigms are the most commonly cited by researchers (Denzin, 1978; Dzurec and Abraham, 1993; Johnson, and Onwuegbuzie, 2004; Guba and Lincoln, 2005; Punch, 2013). However, Schwandt (2000, 206) has taken issue with these “paradigm wars,” calling into question the need for the divisions or differentiation between quantitative and qualitative research dimensions. In his view, “it is highly questionable whether such a distinction [between qualitative inquiry and quantitative inquiry] is any longer meaningful for helping researchers to understand the purpose and means of human inquiry” (2000: 210). Schwandt (2000: 210) also declared the following:

All research is interpretive, and we face a multiplicity of methods that are suitable for different kinds of understandings. So the traditional means of coming to grips with one's identity as a researcher by aligning oneself with a particular set of methods (or being

defined in one's department as a student of "qualitative" or "quantitative" methods) is no longer very useful. If we are to go forward, we need to get rid of that distinction.

In the wake of Schwandt's views, there has been a resurgence of the *mixed methods* (blended) research paradigm – which Johnson, et al (2007: 113) define as “an approach to knowledge (theory and practice) that attempts to consider multiple viewpoints, perspectives, positions, and standpoints (always including the standpoints of qualitative and quantitative research)”. In similar vein, Greene (2008: 20) has subsequently defined the ‘mixed methods way of thinking’ as “an orientation toward social inquiry that actively invites us to participate in dialogue about multiple ways of seeing and hearing, multiple ways of making sense of the social world, and multiple standpoints on what is important and to be valued and cherished.”

In looking at the research questions that undergird this study, the mixed methods paradigm was found to be the appropriate research paradigm for the study because the researcher needed to collect both qualitative and quantitative data in order to adequately address the research questions.

1.9.2 Research Design

As a mixed methods research project, there were two designs applied. The first was a Case Study design, in order to address the first two research questions. The second research design was the Non-equivalent Groups quasi-experimental research design. This latter design was used to address the third research question.

1.9.3 Target Population, Sampling Techniques and Research Sample

This study was conducted within the King Cetshwayo District of the Province of KwaZulu Natal, South Africa. Altogether, four schools offering Foundation Phase education were involved, giving a total of three hundred and twenty-eight learners. For reasons of accessibility, the study was confined to the Nseleni, Richards Bay and Esikhaleni Circuits. Simple random sampling was used to select the four participating schools from these Circuits.

1.9.4 Research Instruments

There were several research instruments used in this study. First, supplementary learning support materials were developed to support and give guidance to the teachers and learners. The

second research instrument was an interview schedule which was used to explore the grade three learners' understanding of a healthy environment and explore the explanations which lay behind their understanding of a healthy environment. The third research instrument was the pre-test which was used to establish the baseline knowledge that the learners had about a healthy environment. The same test also served as a posttest to measure the comparative gains that the learners had made following the two respective interventions.

1.9.5 Data Collection Procedures

Data collection involved individual and focus-group interviews with learners, as well as the use of a written test. The use of focus group interviews helped to maximise on learner participation – as Broström (2012: 5) observes, “child interviews give the children a voice.” Focus group interviews enabled the researcher to interview several groups of learners, enabling higher levels of participation, in addition to the individual learner interviews. The written test was administered in the usual way as class tests. Permission was requested and obtained to have all the interviews voice-recorded so that the interviewers could focus on the conversations with the learners rather than, for instance, on note-taking.

1.9.6 Data Analysis Approaches and Techniques

Qualitative data arising from the administration of the interview schedule were analysed based on the hermeneutical approach as it “allows one to focus on the text produced according to the question asked as an expression of the respondents' personal experiences and accepted values” (Läänemets, et al, 2012: 29). Furthermore, in hermeneutical analysis, information can be analysed at multiple levels and from different points of view. Hermeneutical analysis is interpretative in nature thus, data analysis is reiterative, ongoing, recursive, and dynamic – evolving from the data rather than based on existing or *a priori* notions (Merriam, 1988; Keeney, Keeney and Chenail, 2015). In this study, the first stage of data analysis involved reading through all the transcripts of the learner responses and creating categories of description to represent emerging themes. This entailed finding patterns from which the themes and conceptual categories could be constructed. In a reiterative process, the recurring themes and conceptual

categories were progressively reduced in number by combining conceptually similar ones, resulting in a consolidated, fewer numbers of categories of descriptions.

Quantitative data were analysed statistically using the Statistical Product and Service Solutions (SPSS). The analysis involved a comparison of the means as a result of the two interventions. In this regard, either the Analysis of Variance (ANOVA) and the t-test statistic were used.

1.10 ETHICAL CONSIDERATIONS

The main focus of this study was on learner conceptions about the environment. Thus, the necessary permission from learners and their parents/guardians had to be secured. In addition, both the University's Ethics Committee and the provincial Education Department were requested to grant ethical clearance before fieldwork commenced. More specifically, the University's Policy and Procedures on Research Ethics and its Policy Procedures on Managing and Preventing Acts of Plagiarism were complied with. All ethical matters were fully discussed with my Promoters to ensure that all ethical issues that may arise from carrying out this research were dealt with appropriately. Furthermore, the various levels of authority affected by this study were approached for their permission, namely the school principals, district and circuit managers.

Typically, researchers are expected to comply with ethical principles related to honesty, accountability, anonymity, privacy and confidentiality. In order to do this, the researcher explained the nature of the study to potential participants and other role players in order to ensure that their participation, or ascent to the study in any other way, was made out of full understanding of what the study was about. Thus, the following information formed part of the brief to the participants: the purpose of the research; procedures used in research; participants' right to decline to participate at any stage of the investigation; potential benefits of the research, anonymity and confidentiality. The researcher also ensured that she acknowledges other researchers' works as required by the etiquette of academic writing.

1.11 DEFINITION OF TERMS

For the purpose of this study, a number of terms were used. The operational definitions of these terms are given below:

1.11.1 Culture

This is defined as “the ever-changing values, traditions, social and political relationships, and worldview created, shared, and transformed by a group of people bound together by a combination of factors that include common history, geographic location, language social class and religion” (Nieto, 1999: 48). Culture consists of “norms, values, beliefs, expectations, and conventional actions of a community. In the everyday culture, students’ cognition is shaped mainly by their daily communications with their physical and social world” (Zhou, 2012: 116). Furthermore, culture provides the rules and guidelines for appraising and interpreting interactions with events, people, or ideas encountered in the everyday life of a community (Fakudze, 2004: 270).

1.11.2 Western science

This is a subculture of Western culture that has norms, values, beliefs, and expectations that are generally shared among its members to explain and understand the physical world (Monteiro, 2015: 8; Sutherland, 2005: 596).

1.11.3 Cultural border crossing

This refers to the transitions learners make as they move between world-view cultures or microcultures (Aikenhead 2001: 284).

1.11.4 Collateral learning

This involves two or more conflicting schemata held simultaneously in long-term memory, manifested in learners’ construction of “scientific concepts side by side, and with minimal interference and interaction, with their indigenous concepts (related to the same physical event)” (Aikenhead and Jegede, 1999: 278).

1.11.5 Parallel collateral learning

This happens where learners keep two or more “kinds of ‘science’ quite separate as if what they did in school was quite different from the activities of remote and knowledgeable scientists” (Aikenhead, 2001: 279). In this situation, the conflicting schemata do not interact at all, and students access one schema or the other to explain an event, depending upon the context – such as when students use a scientific concept of energy only in school and never in their everyday world where concepts based on their day-to-day experiences of energy prevail (Aikenhead and Jegede, 1999: 278).

1.11.6 Simultaneous collateral learning

In simultaneous collateral learning, a concept in one domain of knowledge or culture can facilitate the learning of a similar or related concept in another learning domain (Fakudze (2004: 271). Thus, simultaneous collateral learning conceptually fits between parallel and dependent collateral learning.

1.11.7 Dependent collateral learning

This takes place where learners “might produce an amalgam or well-stirred mixture of the two kinds of knowledge.” (Aikenhead, 2001: 279). This happens when a schema from one worldview or domain of knowledge challenges another from a different worldview or domain of knowledge, to an extent that permits the student to modify an existing schema without radically restructuring the existing worldview or domain of knowledge (Fakudze, 2004: 271).

1.11.8 Secured collateral learning

This is where learners “might be able to reflect on the similarities between their own work in science and that of scientists” – postulated to take place where learners are “enabled to discuss the purposes of experiments and the status of theory in their own work.” (Aikenhead, 2001: 279).

1.11.9 Preconceptions

The term refers to learners’ conceptions (i.e. understanding of the world) formed before receiving formal instruction in class. (Zhou, 2012: 112).

1.11.10 Enculturation

This is a process whereby a student accommodates school science into his/her cosmology whilst retaining his/her sense of identity. According to Schwartz, Unger, Zamboanga and Szapocznik (2010: 237), “*acculturation* refers to changes that take place as a result of contact with culturally dissimilar people, groups, and social influences.”

1.11.11 Assimilation

This is the process of subsuming a learner’s worldview to that of science by abandoning his or her traditional worldview to that of science. This requires the learner to intellectually shift from his or her everyday life-world with its traditional worldview suppositions to that of school science, hence undergoing a process known as cognitive border crossing.

1.11.12 Scaffolding

Refers to the context and support provided by knowledgeable people, such as adults, to help children to develop their cognitive skills. An important aspect of scaffolding is that the support is gradually withdrawn as the child’s knowledge and confidence increase.

1.12 CONCLUSION

The aim of this chapter was to introduce the reader to the research problem, its setting and various aspects of the study as a whole. This included a short introduction, a brief review of literature, statement of the problem and research questions, a motivation for the study, a brief overview of the methods of study, as well as some reflections on some ethical issues. The researcher believes that the chapter has succeeded in orientating the reader about the study as a whole. The next chapter presents a comprehensive review of literature with a view to proving a theoretical basis for the study.

CHAPTER TWO

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 INTRODUCTION

Early Child Education (ECE) refers to children's development from birth to nine years of age. South Africa's Foundation Phase of the school system constitutes the latter four years of the ECE phase and thus the initial stage of schooling (Beni (2014: 1). This is a very important stage of a child's development when a solid foundation for further learning should be laid through, *inter alia*, the acquisition of society's espoused skills, knowledge, attitudes and values. Within this context "the foundation phase aims to strengthen learner awareness of social relationships, technological processes and elementary science" (Kok and van Schoor, 2014: 96). However, it is presently known that children come to school with their own understanding of the world, generally, and about certain concepts, in particular. These notions about the world are not irrational because they have been built out of the children's authentic experiences of their life-worlds – as Kok and van Schoor (2014: 98) further observe:

Children's understanding of science concepts is based on their range of experiences and interactions, and on the development of concepts that help to explain the phenomena. *Situated cognition theory* defines learning as the knowledge and skills

obtained in contexts that reflect the ways in which knowledge and skills are used in real life. Genuine understanding comes from the situations in which learning occurs.

However, through exposure to increasing sets of experiences – including school learning and through the attendant social learning interactions, young children start to develop concepts that may begin to resemble more closely the scientifically accepted worldview. It was in this respect that this study set out to address the following three research questions:

- What conceptions do grade three learners have of the construct of a healthy environment?
- What explanations lie behind the learners' conceptions of a healthy environment?
- Will there be a statistically significant difference in learner achievement between those taught through a cognitive conflict-based conceptual change approach versus those taught through an instructional approach based on Collateral Learning Theory?

Accordingly, the literature review has been presented in line with these research questions.

2.2 GRADE THREE LEARNERS' CONCEPTIONS OF A HEALTHY ENVIRONMENT

This section starts by reflecting on the concept of a health environment – against the spectre of a number of health risks which young children, in particular, are ordinarily exposed to. Subsequently, the notion of a healthy environment is contextualised within South Africa's Curriculum and Assessment Policy Statement (CAPS) (DBE, 2011). The final subsection presents a synopsis of the empirical studies which have been carried out on Foundation Phase or Primary School learners' conceptions of a healthy environment.

2.2.1 A Healthy Environment

World-wide, the concept of a healthy environment has not only become topical but also extremely important. In big measure, this importance has come about as a result of the perceived threat to the environment, and what many people see as the imminent demise of Planet Earth. In fact, such is the threat to Earth's environment that the notion of *environmental security* has emerged. The view is that unless very strong and broad-based measures are taken urgently by all

the countries of the world, there is imminent catastrophe that awaits to befall Planet Earth.

Holmes (2015: 20) explains this matter as follows:

Environmental security is an idea with multiple meanings. One is the more traditional concept of responding to conflicts caused by environmental problems such as water shortages, energy disruptions, or severe climate changes; it is assumed that these problems are “transnational” and thus can cause conflict between nations. The other, more recent concept is that the environment and the “climate” should be protected as ends in and of themselves; the assumption is that the environmental degradation caused by man is a threat that must be addressed by treaties and international governance as if it were the moral equivalent of a national security threat. In the past, natural disasters were not considered threats to national security, but that presumption is changing as the ideology of “climate change” and global warming takes hold in the national security community.

Prüss-Üstün and Corvalán (2006: 9) report that globally, an estimated 24% of the disease burden (healthy life years lost) and an estimated 23% of all deaths (premature mortality) are attributable to environmental factors. They further report that among children between birth and fourteen years of age, “the proportion of deaths attributed to the environment was as high as 36%.” Much of this happens as a result of changes in the environment, as Prüss-Üstün and Corvalán (2006: 9) explain, “diseases with the largest absolute burden attributable to modifiable environmental factors included: diarrhoea; lower respiratory infections; 'other' unintentional injuries; and malaria.” In the case of diarrhoea, Prüss-Üstün and Corvalán (2006: 9) aver that “an estimated 94% of the diarrhoeal burden of disease is attributable to environment, and associated with risk factors such as unsafe drinking-water and poor sanitation and hygiene.” In addition, lower respiratory infections “are associated with indoor air pollution related largely to household solid fuel use and possibly to second-hand tobacco smoke, as well as to outdoor air pollution”; that “in developed countries, an estimated 20% of such infections are attributable to environmental causes, rising to 42% in developing countries” (Prüss-Üstün and Corvalán, 2006: 9). Overall, it appears that developing countries carry a disproportionately much higher burden of life years lost per capita than developed countries:

The total number of healthy life years lost per capita as a result of environmental burden per capita was 15-times higher in developing countries than in developed countries. The environmental burden per capita of diarrhoeal diseases and lower respiratory infections was 120- to 150-times greater in certain WHO developing country sub-regions as compared to developed country sub-regions. These differences arise from variations in exposure to environmental risks and in access to health care. (Prüss-Üstün and Corvalán, 2006: 11).

Prüss-Üstün and Corvalán (2006: 10) also report that the proportion of malaria attributable to modifiable environmental factors is as high as 42%, and that this is “associated with policies and practices regarding land use, deforestation, water resource management, settlement siting and modified house design, e.g. improved drainage.” As Üstün and Corvalán (2006: 10) further explain:

An estimated 42% of chronic obstructive pulmonary disease (COPD), a gradual loss of lung function, is attributable to environmental risk factors such as occupational exposures to dust and chemicals, as well as indoor air pollution from household solid fuel use. Other forms of indoor and outdoor air pollution – ranging from transport to second-hand tobacco smoke – also play a role.

Equally importantly are environmental factors, such as inadequate pedestrian and cycling infrastructures, which also “make a significant contribution to injuries from road traffic accidents” amounting to 40% (Üstün and Corvalán, 2006: 10). In this regard, Üstün and Corvalán (2006: 12) also report that “developing countries, meanwhile, carry a heavier burden of disease from unintentional injuries and road traffic injuries attributable to environmental factors.” They report as follows:

In developing countries, the average number of healthy life years lost, per capita, as a result of injuries associated with environmental factors, was roughly double that of developed countries; the gap was even greater at the sub-regional level. For road traffic injuries, there was a 15-fold difference between the environmental burden of

disease in the best performing and worst-performing sub-regions, and a 10-fold disparity for 'other' unintentional injuries. (Üstün and Corvalán, 2006: 12).

Quite frequently, young people are exposed to adverse environmental conditions which cause cardiovascular ailments. This situation is typically also associated with lack of physical activity, which could obviate disease and other unhealthy conditions not only in children but in adults as well. Üstün and Corvalán (2006: 12) explain this situation as follows:

The number of healthy life years lost from cardiovascular disease, as a result of environmental factors, was 7-times higher, per capita, in certain developed regions than in developing regions, and cancer rates were 4-times higher. Physical inactivity is a risk factor for various noncommunicable diseases including ischaemic heart disease, cancers of the breast, colon and rectum, and diabetes mellitus. It has been estimated that in certain developed regions such as North America, physical inactivity levels could be reduced by 31% through environmental interventions, including pedestrian- and bicycle-friendly urban land use and transport, and leisure and workplace facilities and policies that support more active lifestyles. (Üstün and Corvalán, 2006: 12).

In all these statistics, “children suffer a disproportionate share of the environmental health burden” (Üstün and Corvalán, 2006: 13). The age range that is highest at risk appears to be children under five years of age, as Üstün and Corvalán (2006: 13) elaborate:

Globally, the per capita number of healthy life years lost to environmental risk factors was about 5-times greater in children under five years of age than in the total population. Diarrhoea, malaria and respiratory infections all have very large fractions of disease attributable to environment, and also are among the biggest killers of children under five years old. In developing countries, the environmental fraction of these three diseases accounted for an average of 26% of all deaths in children under five years old. Perinatal conditions (e.g. prematurity and low birth weight); protein-

energy malnutrition and unintentional injuries – other major childhood killers – also have a significant environmental component, particularly in developing countries.

The impact of adverse environmental factors on the health of children is quite high, as Üstün and Corvalán (2006: 14) report:

On average, children in developing countries lose 8-times more healthy life years, per capita, than their counterparts in developed countries from environmentally-caused diseases. In certain very poor regions of the world, however, the disparity is far greater; the number of healthy life years lost as a result of childhood lower respiratory infections is 800-times greater, per capita; 25-times greater for road traffic injuries; and 140-times greater for diarrhoeal diseases. Even these statistics fail to capture the longer-term effects of exposures that occur at a young age, but do not manifest themselves as disease until years later.

Thus, the importance of a healthy environment cannot be overemphasised, particularly insofar as children are concerned. As Bellamy (2003: 157) observes, “young children pay the greatest price for our failure to ensure universal access to safe water and sanitation.” Explaining this point further, Bellamy avers as follows:

The largest single cause of childhood illness and death is diseases caused by unsafe water and poor or non-existent sanitation. One in four of the nearly 11 million children who die each year before reaching their fifth birthday, almost all in developing countries, succumb to infections related to water and sanitation. Millions more are malnourished or physically and mentally disabled. Hundreds of millions of school-aged children and adolescents are infected by parasites that cause or exacerbate malnutrition, anaemia and other conditions. Bellamy (2003: 157).

Without doubt, one of the most critical ingredients of a health environment is clean water. However, quality, clean water is increasingly becoming a rarity across the world, especially for poor and displaced communities. In this regard, Anderson (2003: 1) explains as follows:

In nature, water (like energy) is neither created nor destroyed but is converted from one form to another. In the natural water cycle, rain falling on the land is mostly transpired by the vegetation. But some percolates to groundwater and some runs off to the rivers and flows to the oceans to evaporate and return as rain. Almost all of the world's water (97%) occurs as salt water. Of the remaining 3%, two-thirds occurs as snow and ice in the polar and alpine regions. So only about 1% of global water occurs as liquid freshwater. More than 98% of the freshwater occurs as groundwater, while less than 2% is available in streams and lakes. So, liquid freshwater is a finite and limited resource. Indeed, if only about 2% of water is available on the surface in streams and lakes for human use, it means that great care ought to be taken to conserve this water for the many human and animal needs.

The compounding factor is that over the centuries, through climatic changes and human development activities, some aspects of the natural water cycle have been impacted negatively – making fresh water supply and availability a major challenge. As Anderson (2003: 1) explains:

Mankind has significantly altered the natural water cycle by overlaying new water cycle elements including: (a) extractions from rivers and groundwater for urban, industrial and agricultural use, (b) urban and agricultural runoff, and (c) return of treated or untreated wastewaters to streams. In many areas of the world, groundwater is the main water resource and often rates of extraction greatly exceed the rates of recharge, so groundwater levels are declining.

A lot of urban activities, such as industrialisation, have been associated with a phenomenal growth in various forms of pollution, which has in turn impacted negatively on, among others, clean and fresh water supplies, particularly in terms of overuse, wastage and declined quality. Thus, with specific reference to water:

Urban development also has had a significant impact on the water cycle. Water drawn for urban water supply reduces stream-flows in rivers. At the same time, storm-water runoff and wastewater discharges, which often carry high levels of pollution, cause a decline in the water quality of rivers. Serious degradation has been observed in some

rivers, which have high levels of urban development in their catchments. (Anderson, 2003: 1).

Mining activities are also associated with heavy metal pollutants when mine water is allowed to flow into rivers. Almost invariably, people downstream who depend on the river water for drinking manifest health problems attributable to the pollutants (Rojas and Vandecasteele, 2007). This view is supported by Yi, Yang and Zhang (2011: 2575) who also point out that “the rapid development of industry and agriculture has resulted in increasing pollution by heavy metals, which are a significant environmental hazard for invertebrates, fish, and humans.”

However, the challenge is not only about the quality of water but also the declining quantities. So, in many places around the world, “a move from the old “use once and throw away” approach, has given way to a new sustainable “conserve, use wisely and recycle” water economy (Anderson, 2003: 9). Miller (2006: 65) explains this point further as follows:

Communities across the world face water supply challenges due to increasing demand, drought, depletion and contamination of groundwater, and dependence on single sources of supply. Water reclamation, recycling, and reuse address these challenges by resolving water resource issues and creating new sources of high-quality water supplies.

Quite significant, the concept of reuse has become central to water conservation. As such, the matter of water conservation through reuse has grown in stature to the level of development policies in many countries. As Miller (2006: 65) explains:

One of the most significant benefits of water reuse is the value created by the inclusion of water reuse in integrated water resources planning and other aspects of water policy and the implementation of water projects resulting in the long-term sustainability of our water supplies. These integrated concepts, which involve the convergence of diverse areas such as governance, health risks, regulation, and public perception, also present a significant challenge to water reuse. These complex connections can assert equal influences on both the benefits and challenges associated with water reuse.

So, within these complex measures aimed at guaranteeing water security have emerged a number of approaches ranging from public awareness and education programmes to technical aspects of water economics and reticulation:

Current trends include addressing emerging pollutants of concern, the use of advanced wastewater treatments including membranes, indirect potable reuse, public perception, understanding the economics of water reuse, groundwater recharge and aquifer storage and recovery, salinity management (including concentrate disposal), increase in the use of “alternative sources”, environmental or natural system restoration, innovative uses of nonpotable water reuse, and decentralized and satellite systems. (Miller, 2006: 65).

Mental health has also not been spared. It is reported that “mental retardation due to lead exposures in general was estimated to be nearly 30 times higher in regions where leaded gasoline was still being used, as compared with regions where leaded gasoline had been completely phased out” (Üstün and Corvalán, 2006: 14).

It is as a result of the far-reaching consequences of adverse health conditions that “many Millennium Development Goals (MDGs) have an environmental health component” as highlighted below (Üstün and Corvalán, 2006: 15-16).

Table 2.1 The Millennium Development Goals highlighting the Importance of a Healthy Environment

MDG	Description	Indicators
1	Eradicate extreme poverty and hunger	<ul style="list-style-type: none"> • Minimizing exposures to environmental risk factors indirectly contributes to poverty reduction, because many environmentally mediated diseases result in lost earnings. • Disability or death of one productive household member can affect an entire household. • Malnutrition is 12-times higher per capita in developing regions, compared with developed regions.
2	Achieve universal primary education	<ul style="list-style-type: none"> • Providing safe drinking-water and latrines at school (particularly latrines for girls) will encourage primary school attendance. • Interventions that provide households with access to improved sources of drinking-water and cleaner household energy sources also improve student attendance, saving time that children would

		<p>otherwise spend collecting water and/or fuel.</p> <ul style="list-style-type: none"> • The same interventions can save children from missing school as a result of illness or injury.
3	Promote gender equality and empower women	<ul style="list-style-type: none"> • Particularly in developing countries, access to improved drinking-water sources, cleaner household energy sources, and more generally, reduction of environmentally-attributable burden of childhood diseases, can save time women now spend in collection of fuel, water, and care for children who become sick. • Time thus saved also can be invested by women in income-generating activities and education, thus contributing to the MDG goal of empowering women and promoting gender equality.
4	Reduce child mortality	<ul style="list-style-type: none"> • The mortality rate in children under five years of age from environmentally-mediated disease conditions is 180 times higher in the poorest performing region, as compared with the rate in the best performing region. • In terms of just diarrhoea and lower respiratory infections, two of the most significant childhood killers, environmental interventions could prevent the deaths of over 2 million children under the age of five every year, and thus help achieve a key target of this MDG – a two-thirds reduction in the rate of mortality among children in that age category.
5	Improve maternal health	<ul style="list-style-type: none"> • Environmental interventions can contribute to this MDG by providing a safe home environment, which is of great importance to the health of children and pregnant mothers. • Conversely, a contaminated home environment is a threat to the mother and her unborn child. Childbirth, for example, requires safe water and sanitary conditions.
6	Combat HIV / Aids, malaria and other diseases	<ul style="list-style-type: none"> • Results of this analysis indicate that over half a million people die every year from malaria, and over a quarter of a million people die from HIV/AIDS, as a result of environmental and occupational causes. • A large proportion of malaria, in particular, may be attributable to readily modifiable environmental factors, such as land use, irrigation and agricultural practices.
7	Ensure environmental sustainability	<ul style="list-style-type: none"> • Diarrhoeal diseases associated with a lack of access to safe drinking-water and inadequate sanitation result in nearly 1.7 million deaths annually. Household use of biomass fuels and coal by over one-half of the world's population, results in 1.5 million deaths a year from pollution-related respiratory diseases. • Enhancing access to improved sources of drinking water, sanitation, and clean energy are therefore key environmental interventions that can reduce pressures on ecosystems from water and air-borne contamination, and also improve health. • Residents in fast-growing cities of the developing world may be exposed to the combined health hazards of unsafe drinking-water, inadequate sanitation, and indoor and outdoor air pollution. • Reductions in such environmental exposures will both improve

		the health and the lives of urban slum dwellers – one of the key targets of MDG-7.
8	Develop a global partnership for development	<ul style="list-style-type: none"> • The underlying message of this study is that both the health sector and non-health sector actors can, and need, to take joint action to effectively address environmentally-mediated causes of disease. • To do this, global partnerships are essential. Many such alliances already exist in the field of children's environmental health; occupational health; in joint health sector and environment sector linkages; and in actions in the water, chemical and air pollution sectors. • Such global partnerships need to be strengthened and reinforced, harnessing the full range of policy tools, strategies and technologies that are already available – to achieve the interrelated goals of health, environmental sustainability, and development.

Source: Table constructed by writer from Prüss-Üstün and Corvalán, 2006: 15-16)

Overall, there are number of benefits associated with a healthy environment. These are aptly captured by Prüss-Üstün and Corvalán (2006: 14):

These benefits include gains in economic productivity as well as savings in health-care costs and healthy life years lost, particularly as a result of diarrhoeal diseases, intestinal nematode infections and related malnutrition. Providing access to improved drinking-water sources in developing countries would reduce considerably the time spent by women and children in collecting water. Providing access to improved sanitation and good hygiene behaviours would help break the overall cycle of faecal-oral pathogen contamination of water bodies, yielding benefits to health, poverty reduction, well-being and economic development.

Some of the health risks associated with children's vulnerability to disease relate to their general low intake of healthy food such as fruits. As Taylor, Evers and McKenna (2005: 20) surmise, "research has revealed that young children tend to "have low intakes of fruits, vegetables and milk products; high intakes of less healthy choices, such as soft drinks and high-fat, high-sugar snack foods; and consumption of too much fat and saturated fat, and too little folate and calcium." So, this poor dietary choice amounts to a very poor state of affairs for children:

Overall dietary quality declines with age, and the rate of breakfast skipping increases. Unhealthy eating habits during childhood may interfere with optimal growth and development while setting the stage for poor eating habits during adolescence and adulthood... Moreover, poor diet and inactivity during childhood have been implicated in the worrisome increase in childhood overweight.

As a result of eating unhealthy foods, there tends to be an increase in “other nutrition-related risk factors for chronic disease in children such as hypertension, hypercholesterolemia and Type 2 diabetes have also been observed” (Taylor, Evers McKenna, 2005: 20).

This calls for “a range of health promotion strategies are required in order to support healthy eating during childhood and adolescence and promote optimal growth and development while reducing risk for obesity as well as chronic disease rates in the adult population” (Taylor, Evers McKenna, 2005: 20). However, “in order to design effective interventions, an understanding of the complexity of factors that influence the eating behaviours of children and adolescents is needed” (Taylor, Evers and McKenna, 2005: 20).

In the meantime, many families around the world continue to bear the heavy burden of disease resulting from unhealthy environments mainly as a result of the deteriorating climatic conditions and war. Indeed, “this enormous burden of preventable sickness and death is a tragedy for children and their families” – and “it is also a blow to development, because it deprives communities and society as a whole of incalculable human potential” (Bellamy, 2003: 157). In the meantime, the sad thing is that:

The world we seek, a world of sustainable development and sound environmental, social and economic policies—in short, a world fit for children — has remained a dream deferred for more years than we can count. But by working together under enlightened leadership, with committed partners, and with a commitment of resources to the plan of action set out in *A World Fit for Children*, we can make that dream a reality for each and every child. (Bellamy, 2003: 157).

To this end, Bellamy (2003: 157) opines that “the young child’s interdependent needs for survival, growth and development require the harmonization of efforts to improve health, nutrition, clean water and environmental sanitation, psychosocial care and early learning, child protection, and women’s rights.” Thus, the importance of focusing on the impact of the environment on children’s health, particularly, has been acknowledged (e.g. Bateson and Schwartz, 2007). This has been so on the realisation that children tend to be more vulnerable than adults to adverse environmental conditions, such as water and air pollution. According to Bateson and Schwartz (2007: 238) reasons for this vulnerability are that children’s lungs are not completely developed, and they tend to have greater exposures than adults. Furthermore, those exposures can deliver higher doses of different compositions of pollutants that may remain in their lungs for greater durations of time. This point is further explained by Bateson and Schwartz as follows:

Children spend more time outside, where concentrations of combustion-generated air pollution are generally higher. Children have higher baseline ventilation rates and are more physically active than adults, thus exposing their lungs to more air pollution. Nasal breathing in adults reduces some pollution concentrations, but children are more typically mouth-breathers—suggesting that the composition of the exposure mixture at the alveolar level may be different. Finally, higher ventilation rates and mouth-breathing may pull air pollutants deeper into children's lungs, thereby making clearance slower and more difficult. Children also have immature immune systems, which plays a significant role in asthma. The observed consequences of early life exposure to adverse levels of air pollutants include diminished lung function and increased susceptibility to acute respiratory illness and asthma. (Bateson and Schwartz, 2007: 238).

It is quite clear, therefore, that children need to be exposed to the study of the environment from a very young age so that apart from being aware of the dangers of an unsafe or unhealthy environment, they are also able to take steps that will prevent high incidences of diseases attributable to an unhealthy environment. Such a level of awareness may also generalise to the work environment when the children have grown up and find themselves in work environments which expose them to high risks of dangers to their health. Certainly, the workplace could be

fraught with hazards – such as radiation and such-like industrial conditions which may cause unintentional injuries.

2.2.2 A Heathy Environment within the context of CAPS

In South Africa, the Foundation Phase curriculum (Grades R to 3) is presented in four subjects, namely (a) Home Language, (b) First Additional Language, (c) Mathematics, and (d) Life Skills (Department of Basic Education, 2011: 6). Natural Science concepts, Scientific Process Skills, and Technological Process Skills are taught under Life Skills, which is in turn divided into four components, namely (a) Beginning Knowledge, (b) Personal and Social Well-being, (c) Creative Arts, and (d) Physical Education. For the purpose of cogency in the curriculum implementation, the first two are presented together, forming an instructional cluster referred to as Beginning Knowledge and Personal and Social Well-Being. This is the component under which Natural Science concepts, which form the focus of this study, are presented. Table 1.1 displays the grade levels at which the topics relevant to the notion of a healthy environment are taught (Department of Basic Education, 2011).

Table 2.2 Topics Related to Healthy Environment in the Foundation Phase

TOPIC	GRADE	TERM
1. Healthy Environment (2 hours) <ul style="list-style-type: none"> • The importance of a clean environment • Ways in which people pollute the environment • The importance of recycling 	R	3
2. Water (4 hours) <ul style="list-style-type: none"> • Uses of water - home and school • Ways water is wasted • Ways of saving water • Safe and unsafe drinking water • Storing clean water 	1	4
3. Recycling (6 hours) <ul style="list-style-type: none"> • What happens to our waste • Re-using (things that can be used again) • Recycling (used things that can be made into something new) • Reducing (using less) 	3	2

<ul style="list-style-type: none"> • What cannot be recycled • Recycling at home and at school • Making compost out of things that rot • Re-using water 		
<p>4. Pollution (6 hours)</p> <ul style="list-style-type: none"> • What pollution is • Different types of pollution - water, land, air, noise • Effects of pollution on people • Effects of pollution on the environment 	3	3

Table 1.1 shows that in addition to the concept of a healthy environment, the important environmental concepts of conservation, recycling, reuse and pollution are all introduced within the Foundation Phase. This study attempted to cover all these concepts in finding out the learners’ conceptions and understanding of a healthy environment.

Pedagogically, the Foundation Phase curriculum is meant to follow a constructivist approach, and science is expected to be taught in an integrated manner. As Kok and van Schoor (2014: 100) aver, CAPS “advocates a constructivist approach which the teaching of the scientific and technological processes would ensure.” They further explain as follows:

Whereas the foundation phase education policy for life skills does not overtly advocate an integrated approach, it implies an integration of science, technology and social issues in stating, as a specific aim, that the life skills programme should expose learners to a range of knowledge, skills and values that strengthen their awareness of social relationships, technological processes and elementary science. (Kok and van Schoor, 2014: 100).

One of the goals of South Africa’s Foundation Phase school curriculum is to have children learn about healthy eating and a healthy environment so that they can begin to influence what they choose to eat and the conditions of the physical environment where they live. This is important when one considers that “approximately one-quarter of the global disease burden, and more than one-third of the burden among children, is due to modifiable environmental factors” (Neira, 2006: 6). Within the school curriculum and in society, generally, “our evolving knowledge about the environment-health interactions can support the design of more effective preventive and public health strategies that reduce corresponding risks to health” (Neira, 2006: 6). In this

regard, some of the measures that could be taken include “the promotion of safe household water storage and better hygiene measures, the use of cleaner fuels and safer, more judicious use and management of toxic substances in the home and workplace” Neira, 2006: 7). In addition, “actions by sectors such as energy, transport, agriculture, and industry are urgently required, in cooperation with the health sector, to address the root environmental causes of ill health” (Neira, 2006: 7).

2.2.3 Empirical Studies on Learners’ Conceptions of a Healthy Environment

To understand the concept of a healthy environment, it is important to reflect on what the term ‘health’ means. The World Health Organization (WHO) defines ‘health’ as “a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity” (Piko and Bak, 2006: 643). Piko and Bak (2006: 643) further explain that this definition calls attention to the fact that health is a complex and multidimensional concept, whereby health is seen as relating to the extent to which an individual or a group is able to change or cope with the environment. This perspective “suggests an ecological perspective, i.e. health is a state of equilibrium/harmony between the physical, biological and social environments” (Piko and Bak, 2006: 643). Thus, taking cue from this understanding of the term ‘health’, a healthy environment may then be construed as one in which individuals and groups of people are in equilibrium and harmony with their **physical, biological and social** environments.

In a study conducted in Kenya among primary school children on the concept of health the children associated the concept with both biomedical and psychosocial aspects of life. Overall, the findings led to the following categories of the children’s understanding of the terms: *being happy, being active, feeling good, the lack of pain* and health-promoting activities, particularly such hygienic issues as *clean food or personal hygiene* (Piko and Bak, 2006: 644). In England, Pridmore and Bendelow (1995) reported that children associated diet/healthy food, fruits and vegetables, sport and exercise, hygiene, not smoking and sleeping with good health, whereas smoking, unhealthy diet, environmental pollution, alcohol, medicine and violence were associated with an unhealthy environment.

Oakley, Bendelow, Barnes, Buchanan and Husain (1995) reported children's notions of a healthy environment as encompassing books or nice home, beyond the usual factors like vitamins, healthy food, sport and hygiene. Aspects constituting an unhealthy environment included being homeless or bombs, in addition to factors such as unhealthy lifestyle. In a study done in Brazil, Boruchovitch and Mednick (1997) reported more cross-cultural similarities than differences in children's concepts of health and illness. In other studies on smoking as a health-related factor, primary school children expressed strong negative attitudes toward smoking, and even children aged between 4 and 7 years had some understanding of the health problems that passive smoking posed to them (Piko and Bak, 2006: 644).

In their study carried out in two primary schools, among children doing grades 3, 4 and 5, in Hungary, Piko and Bak (2006:643) found that the children had "considerable knowledge about health, illness and disease risks." Some of the children's responses reported in Piko and Bak (2006: 647) concerning 'the state of being healthy' are both important and interesting:

When I am healthy, this means that I am happy (11-year-old girl)

Health has a meaning for me like well-being, happiness, joy. Health is a human strength.
(11-year-old girl)

If I am healthy I go to school and I enjoy the company of my friends and classmates (10-year old girl)

Healthy ... when someone takes regular sports activity, eats healthy food and feels O.K.
(8-year-old boy)

In addition, Piko and Bak (2006) reported that the children in their research sample seemed to be health-conscious and held positive attitudes toward health and health promotion. Furthermore, many of them demonstrated a biomedical approach to health, although a holistic view of health also predominated. The concept of causation was also common, whereby children felt that when they were sick it was probably punishment for previous bad behaviour.

Littledyke (2002: 6) reported that "children who recognised the term environment identified it with the categories: the world, living things in general or with the living or non-living

environments, whilst some associated environment with protecting and caring for these categories.” Further, some of the respondents identified the term directly with environmental problems, while older or more able children “generally showed understanding, which included inclusive or global concepts, such as the world at large, wildlife in general or aspects of pollution.” From this study, the categories of concern which were cited most frequently by the children “were those involving animals and waste, with transport and pollution issues becoming more significant among older children” (Littledyke, 2002: 8). Littledyke explained his results further as follows:

All these issues had immediate relevance to the children, though few showed extensive understanding, and many had misconceptions. Concern for animals in some form was a feature in all interviews and is likely influenced by the identification which children have for pets and with the anthropomorphic representations of animals which are extensively portrayed in children's literature, film and TV programmes. Waste, as litter, was usually seen as a problem because it is unsightly and all children were well aware of the need to "put rubbish in the bin", though few identified rubbish as resources which come from the Earth. (Littledyke, 2002: 8).

Many of the students also saw the value of “recycling through recycling activities at home, though few made connections with the production of consumer goods, with the resulting energy use, pollution and waste as reasons for recycling” (Littledyke, 2002: 8). Furthermore, many of the participants in Littledyke’s study identified pollution as litter, while air pollution was linked commonly to car pollution. As a result of this, some older children expressed strong anti-car sentiments.

Beyond cognitive aspects of a healthy environment, it is also important to deep into children’s beliefs. This could help in health promotion and health education programmes and interventions. Like in cognitive aspects of their growth, children’s belief systems of a healthy environment are also developed through their own experiences. For example, if children are made to believe that illness is caused by infections, they will tend to think about disease in this way, whereas those

believing that when they are sick it is because someone has bewitched them, will tend to think about disease as involving witchcraft. As le Grange (2007: 588) observes:

In South African classrooms learners experience cognitive dissonance when learning about certain phenomena in science classrooms. For example, the scientific perspective that lightning is caused by the discharge of electricity between clouds or from a cloud to the earth is in conflict with learners' cultural understanding that lightning is caused by, for example, witchcraft.

Therefore, it appears that there is a need to conduct more research in the perceptions of learners concerning the notion of a healthy environment, and the interaction between the environment and communities, particularly among children coming from indigenous communities.

2.2.4 Concluding the Section

Environmental education has commonly been defined as education *about* the environment, *in* and *through* the environment, and *for* the environment (Littledyke, 2002: 13). This means that environmental education must include cognitive understanding of environmental matters, direct experience of studying and working in the environment, as well as values and attitudes appropriate to environmental protection.

With regard to the teaching of environmental education in the schools, this continues to be undermined by a lack of a 'subject status'. As such, Littledyke (2002: 13) believes that "the identification of environmental education as a cross-curricular theme, without the emphasis of a subject status and the location of much of the environmental content within geography has meant that science education is not generally being developed in this way." This point appears to also apply to South Africa in the sense that science does not have a subject status in the Foundation Phase, where it is lumped together with a plethora of many other topics under a nebulous subject called Life Skills. From the name 'Life Skills' you cannot tell that hidden in this name is a section dealing with science topics. In contrast, mathematics stands out as a subject in its own right within the Foundation Phase curriculum.

Going back to the study by Littledyke (2002: 17-18), he further reported that a large majority of respondents in his study cared about the state of the world in which they were growing up in, and many had strong feelings about the environment. However, although they had heard of many of the important issues affecting the environment, they lacked “understanding of key ideas and relationships to help them make informed judgements on them.” In respect, Littledyke expressed the fear that “these conditions are likely to be common in primary schools, and this poses the challenge for development of science education which acts as a vehicle for environmental cognitive and moral development” (Littledyke, 2002: 18). As such, he surmises that “such an approach to science can provide a basis for creating a scientifically, environmentally and ethically educated society. (Littledyke, 2002: 18).

Nonetheless, Littledyke believes that science teachers must take the challenge of teaching environmental science seriously, and follow the following principles as a guide:

- Choose topics which are relevant and interesting to children and which provide vehicles for environmental education as well as science, such as waste, animals, pollution, transport;
- Handle science as a process of learning which not only produces ideas, but also has application in the world through technology;
- Take note that although these technological applications may be beneficial, they can also be destructive;
- Introduce scientific concepts which explain various connections of cause and effect, such as litter as resources used for consumer goods which need resources from the Earth to make, which use energy to produce pollution in the process and which produce problems of unsightliness, hygiene, danger from accidents and waste;
- Develop empathy and care for living things, especially considering that this seems to be strongly present in most primary children;
- Consider environmental moral issues which take into account the effect on ecosystems as well as the social impact in environmental issues;

- Consider what action would be appropriate in different circumstances, for instance, “What will you do when you're older?” or “What would you do if you were the President?”
- The use of drama is particularly useful in exploring the implications and consequences of action in relation to environmental issues. (Littledyke, 2002: 17).

Prokop, Fančovičová and Krajčovičová (2015: 1) aver that “children’s ideas concerning natural phenomena often differ from those of scientists, and these ideas are termed as alternative conceptions.” Prokop, et al., attribute this difference to the limited experience young people have, in their interaction with the world, as compared to adults:

The prevalence of alternative conceptions is highest among young children who possess less experience with the natural world as compared with adults. Children’s ideas about micro-organisms are of special importance, because an improved awareness of them may reduce risk of contamination by pathogenic infection. (Prokop, Fančovičová and Krajčovičová, 2015: 1).

This study was based on the notion that it was important to ascertain whether changes among children’s ideas of a healthy environment could be fostered better through the notion of conceptual change or through collateral learning. It was envisaged that the outcome of such an investigation would be useful in improving environmental education.

2.3 THE NOTION OF CONCEPTUAL CHANGE

One possible starting point for explaining conceptual change is to understand the term ‘concept’. However, the word ‘concept’ has proved controversial for philosophers and psychologists (Riordan, 2014: 18). According to Eysenck and Keane (2005: 313) a concept is understood within Aristotle’s Defining Attribute Theory, which sees a concept as being “characterised by a set of defining attributes, which are those semantic features necessary and sufficient for something to be an instance of a concept.” However, “a series of discoveries by psychologists in the 1970s undermined this theory” – thereby rendering it of little value (Riordan, 2014: 19). Subsequently, two competing theories have emerged. One of these is referred to as the Prototype Theory, based on the notion that a concept connotes a category of objects or ideas that share a “central description or prototype that in some way stands for the whole category... the prototype

is a set of characteristic attributes... in which some attributes are weighted more than others (Eysenck and Keane, 2005: 297).

In contrast, the Exemplar Theory advanced by Nosofsky (1991) and Kruschke (1992) argues that “concepts are particular instances (exemplars) of a category that come to mind in a certain situation” (Riordan, 2014: 19). One weakness associated with these two theories, which is of importance to this study, is that none of these theories “takes into account the effect of prior knowledge on the acquisition of new concepts” (Riordan, 2014: 19). In this regard, there is a view that a comprehensive theory of concept formation is still a long way away, and that it “will probably need to combine elements of the prototype and exemplar approaches with a recognition of the effect of prior knowledge” (Riordan, 2014: 19).

The difficulty of defining the term ‘concept’ transfers to the understanding of ‘conceptual change’, which Riordan (diSessa, 2014: 21) contends “represents one particularly challenging type of learning.” In venturing a definition of conceptual change, Illeris (2007: 3) opines that this represents any process that takes place in living organisms leading to “permanent capacity change and which is not solely due to biological maturation or aging.” To diSessa (2006: 265) ‘conceptual change’ embodies “a first approximation of what constitutes the primary difficulty: students must build new ideas in the context of old ones; hence, the emphasis on ‘change’ rather than on simple acquisition. Strong evidence exists that prior ideas constrain learning in many areas.”

In general, there is a view that, in a systematic way, conceptual change-based research was started by Piagét in his studies which described the differences in the ways children of different ages thought about, or construed, certain things or concepts (Piagét, 1952). From Piagét’s studies came a huge interest in this ‘genetic epistemology’ research which manifested itself in the *misconceptions movement* within science education, developmental psychology and experimental psychology – starting in the late 1970s and becoming prominent in the 80s, albeit tailing off from the early 1990s onwards (2006). To-date, this research still influences how many teachers understand how learners learn and, therefore, how they should approach teaching. In particular, one dominant research outcome has been that learners come to school with ways of thinking which may be at variance with what school espouses. This research finding was

associated with a secondary finding that such variant ideas “interfere with their learning and therefore must be overcome” (Riordan, 2014: 22). As Riordan (2014: 22) avers, “most importantly, children’s ideas were frequently viewed as having a negative influence which encouraged conflict models for their resolution.”

The notion of ‘conceptual change’ has, itself changed from what was initially envisioned by Posner et al., in 1982. As Duit and Treagust (2012: 49) explain:

... the development of theoretical conceptual change perspectives shows that conceptual change has grown to one of the leading paradigms in research on teaching and learning. It is interesting to see a continuous progress since early conceptual change research occurred and to realize that the definition of what changes in conceptual change has revised substantially over the past three decades ... Initially, the term change was frequently used in a somewhat naïve way – if seen from the inclusive perspectives that have since developed. The term conceptual change was even frequently misunderstood as exchange of the students’ pre-instructional (or alternative) views for the science view.

Riordan (2014: 22) identifies three ‘traditional’ focus research into conceptual change, namely (a) the exploration of cognitive factors, which includes an attempt to list children’s ‘misconceptions’ in science; (b) a developmental perspective, which examined the origins of children’s alternative conceptions; and (c) the exploration of conceptual change pedagogy.

From the theoretical point of view, conceptual change theorists have tended to fall under two competing theoretical perspectives: knowledge-as-theory and knowledge-as-elements (Riordan, 2014: 22). According to Riordan, (2014: 22-23) the theoretical debate concerning conceptual change “emerged from research into the philosophy and history of science and has had enormous significance on the history of conceptual change research, continuing both to divide current conceptual change theorists and to influence this present study. The notion of knowledge-as-theory originates from Thomas Kuhn’s postulate that scientific change is discontinuous, characterized by periods of ‘normal science’ (where scientists engage in solving puzzles) being peppered with sharp ‘paradigm shifts’ in terms of which the claims of the new theories cannot be stated in the old terms after such shifts have been made; that, in fact, after such paradigm shifts

have been made the old ‘concepts’ come to refer to different things (Riordan, 2014: 23). When a paradigm shift has occurred, it changes what problems are amenable to study, how theories are evaluated, what methods are reliable and even what symbolic generalizations apply (Riordan, 2014: 23).

The knowledge-as-elements perspective is attributed to Toulmin who has argued in favour of an evolutionary model which “saw conceptual change as the collection and coordination of a large set of elements” whereby children’s ideas are seen as “building materials to be moulded for use” (Riordan, 2014: 23-24). Overall, theorists from the knowledge-as-elements perspective argue that conceptual change “involves a piecemeal evolutionary process rather than a broad theory replacement process” (Özdemir and Clark, 2007: 355).

Although there appears to be a third, middle-of-the-road, view which opines that “conceptual change involves both evolution and revolution”, the reality is that the divide between knowledge-as-theory and knowledge-as-elements “influences what each community propose practitioners should do to promote conceptual change” (Riordan, 2014: 24). As Riordan (2014: 24) explains, for some time now, the followers of the knowledge-as-theory perspective have “encouraged the view that conceptual change followed from a combination of dissatisfaction with naïve concepts, together with the perceived intelligibility and plausibility of the scientific concept at issue, and ‘fruitfulness’ (the new idea must appear useful to the pupil in solving problems).” Overall, “the idea that a learner’s conceptual ecology (concepts, ontological categories and epistemological beliefs) influences learning and problem-solving is still influential with both types of theorists” (Riordan, 2014: 24). However, both theories believe that “ontological commitments can constrain a learner’s ability to restructure their thinking,” while “incorrect ontological classification of concepts by students, and the lack of a category to which a concept could be assigned, are both barriers to conceptual change” (Riordan, 2014: 24-25). Table 2.3 describes “ten types of conceptual change, ranging from relatively minor cognitive shifts at the bottom of the table to extremely challenging changes at the top” (Riordan, 2014: 26). For instance, “adopting a new ‘explanatory model’ without relinquishing an old one, is one type of conceptual change” (Riordan, 2014: 26). In Table 2.3 this is typology number 8.

Table 2.3: Types of conceptual change in science (Source: Riordan, 2014: 27)

NO	NAME	DESCRIPTION
10	Paradigm Shift	A theory that differs significantly from the original in many ways.
9	Branch jumping or tree switching	A concept is replaced with an ontologically different type of concept.
8	Differentiation or integration	An explanatory model is divided or joined.
7	New model creation	A new explanatory model is created which has not developed from a previous one.
6	Synthesis or combination	'Overlapping' explanatory models are separated or separate models are integrated.
5	Major model modification	An element of an explanatory model is added, removed or changed.
4	Abstraction from exemplars	A concept (or schema) is formed from exemplars.
3	Applicability change	The conditions indicating when an explanatory model can be used are changed.
2	Minor model adjustment (also called 'tuning')	Small changes are made within an explanatory model
1	Concept change	One concept is changed for another.

In a general sense, Treagust and Duit (2009: 91) understand the term 'conceptual change' to denote "learning pathways from students' pre-instructional conceptions to the science concepts to be learned." More specifically, they construe the term as referring to "learning in science domains where the pre-instructional conceptual structures of the learners are fundamentally restructured in order to allow understanding of the science concepts under consideration" (p. 91). Liu, Hou, Chiu and Treagust (2014: 134) posit that conceptual change entails "the integration of preconceptions and the to-be learned concepts in which learners have altered and accommodated the preconception to new conceptions in the process of understanding the desirable or intended knowledge." However, Riordan (2014) has pointed out, conceptual change is now just about knowledge. As Liu, et al. (2014: 134) aver, "the difficulties of changing scientific conceptions mainly from the cognitive perspective of learning, e.g., measurable cognitive outcomes, have been explored in empirical research" and what has emerged is that "the emotion and intention

domains clearly play a significant role in science learning.” Thus, it is argued then, that “students’ learning emotions and intentions can facilitate or hinder conceptual change”, given “that science learning takes place in complex settings of cognitive, epistemic, and social practices in which the psychological component is rarely researched” (Liu, et al., 2014: 134). For this reason, Liu et al. (2014: 134) aver that “it is crucial to recognize the value and importance that this psychological component plays in science learning” considering that “the ontological categorization of concepts can be used to explicate the situation of conceptual change.” Liu, Hou, Chiu and Treagust (2014: 134) explain this point as follows:

Investigations of the difficulty of conceptual change using the ontological categories of matter and process have shown that if the to-be-learned concepts and the prior knowledge are ontologically compatible— for instance, both are matter which can be contained, have weight, and occupy space (like trees and coal)—then conceptual change is more easily completed ... When the two concepts are ontologically distinct, learning becomes difficult. If students lack awareness of when a shift is necessary or lack an alternative category to shift into, the process of conceptual change also becomes difficult.

Zou (2012) describes two models of conceptual change, namely the ‘cold’ and the ‘warm’ models of conceptual change. According to Zou, the cold model sees conceptual change as purely a matter of logical articulation of the subject matter, whereas the ‘warm’ model adds motivational factors into the process of conceptual change. To this end, it is argued that although the logical aspects of a given knowledge characteristic may be clear and easy to follow, a learner who has no interest in the subject matter, or does not see its value, may simply dismiss it. As Zou (2012: 112) explains, “the message characteristics may never be fully processed by a learner if the affective appraisals create a strong tendency to dismiss the message.” Thus, “the ‘cold’ model for conceptual change describes conceptual change as a logical process while the ‘warm’ models acknowledge the importance of motivation and belief constructs in this process” (Zou, 2012: 112). However, despite this difference, “both cold and warm models share a similar definition of conceptual change: replacement of students’ ideas with scientific notions” (Zou, 2012: 112).

Duit and Treagust (2012) argue that the criticism against the model of conceptual change posed by Posner et al., that it neglected to include affective factors is not fully justified. Instead, Duit and Treagust (2012: 45) content that “the ‘classical’ conceptual change approach – at least implicitly – includes affective variables as influential factors (moderating variables) in facilitating conceptual change.” However, they concede that originally, “affective variables were primarily seen as variables needed to support conceptual change” and that earlier research appeared to have neglected to recognize that affective variables such as interest or self-concept also needed to be deliberately developed during instruction – as they also needed to undergo conceptual change by being developed through the same notions of dissatisfaction, intelligibility, plausibility and fruitfulness (Duit and Treagust, 2012: 45). Some authors (e.g. Zembylas, 2005) have argued, not only for the necessity of linking cognitive and emotional variables of science learning, but that they should both be seen as variables of equal status in the learning process. The implication of this is that in the determination of the occurrence of conceptual change, both cognitive and affective aspects of change must be looked at. In this regard, Duit and Treagust posit as follows:

The development of affective variables during instruction is often not viewed as the outcome per se. Only more recent multi-dimensional conceptual change perspectives as outlined above consider both cognitive and affective outcomes ... With regard to cognitive outcomes, there appears to be ample evidence in various studies now that these approaches are more efficient than traditional approaches dominated by transmissive views of teaching and learning. This seems to be the case in particular if more inclusive conceptual change approaches based on multi-dimensional perspectives are employed.

Accordingly, Duit and Treagust (2012: 47) point out as follows:

Research has shown, however, that much care is needed if cognitive conflict strategies are used for facilitating conceptual change. It is not only necessary to carefully ensure that students experience the conflict but also consider the role of specific, usually small scale, sudden insights within the long-lasting gradual process of conceptual change.

With regard to instructional strategies associated with the notion of conceptual change, Riordan (2014: 35) contends that “the field of conceptual change has changed so much since the misconceptions movement that approaches to instruction must be considered in the context from which they emerged.” In this regard, Riordan observes that particular instructional strategies are often influenced by the dominant theoretical perspectives of a particular time in history. As he points out “early review of instructional strategies for conceptual change in science comes from an era when it was believed that various aspects of scientific investigation could be investigated independently” (Riordan, 2014: 35). However, later instructional strategies were influenced by the “information processing” movement.

Whatever the case, however, the view that conceptions can be easily replaced – one by another, was an over-simplification of the classroom reality. As Vosniadou (in Duit and Treagust, 2012: 44) explains, a simple exchange of students’ pre-instructional (‘alternative’) conceptions is not possible:

Conceptual change is considered not as a replacement of an incorrect naïve theory with a correct theory but rather, as an opening up of conceptual space through increased meta-conceptual awareness and epistemological sophistication, creating the possibility of entertaining different perspectives and different point of views.

According to Treagust and Duit (2009: 91), the model of conceptual change advanced by Posner et al., in their 1982 seminal paper, was based on the notion that student dissatisfaction with a prior conception would “initiate dramatic or revolutionary conceptual change.” It rested on the quadriga of ‘dissatisfaction, intelligibility, plausibility and fruitfulness’, and was “embedded in constructivist epistemological views with an emphasis on the individual’s conceptions and his/her conceptual development” (Treagust and Duit, 2009: 91). So, the view was that “if the learner was dissatisfied with his/her prior conception and an available replacement conception was intelligible, plausible and/or fruitful, accommodation of the new conception may follow” (Treagust and Duit, 2009: 91-92). According to Treagust and Duit (2009: 92) “an intelligible conception is sensible if it is non-contradictory and its meaning is understood by the student; plausible means that in addition to the student knowing what the conception means, he/she finds the conception believable; and, the conception is fruitful if it helps the learner solve other

problems or suggests new research directions.” More specifically, the conceptual change model by Posner, et al (1982), as well as similar instructional approaches involve an ‘elicit, confront and resolve’ strategy, whereby the teacher:

... first elicits a response (prediction about what will happen or an indication of agreement or disagreement with a given statement) from students, forcing them to commit to an answer in relation to a specific situation. Next, the students confront a situation that challenges their beliefs and answers, typically in an experiment that the students perform. During this second phase, if the students were incorrect in their prediction, they experience cognitive dissonance when confronting the conflict between prediction and experience. Students quickly come to realize the need for a new understanding about the concept under consideration, and are motivated to resolve the conflict with teacher assistance in phase three. (Wenning, 2008: 14).

The cognitive conflict model is associated with the concept of ‘status of a learner’, which refers to the extent to which the given conception meets these three conditions of intelligible, plausible and fruitful (Treagust and Duit, 2009: 92). Thus, an important aspect of conceptual change is a learner’s conceptual status, such that if a competing conception does not generate dissatisfaction, the new conception may be assimilated alongside the old one. When dissatisfaction between competing conceptions reveals their incompatibility, two things may happen – where the new conception achieves a higher status than the prior conception, conceptual exchange, may occur, but if the old conception retains higher status, conceptual exchange will not proceed for the time being. It should be remembered that a replaced conception is not forgotten and the learner may wholly or partly reinstate it at a later date because the learner, not the teacher, makes the decisions about the status of the new concept and any conceptual changes. After the learning experience, “the resultant conceptual changes may be permanent, temporary or too tenuous to detect” (Treagust and Duit, 2009: 92).

Conceptual change has also been defined severally by different authors. To Vosniadou (in Zou, 2012: 115), conceptual change is “a restructuring of a preconception.” However, this definition presupposes that students’ less acceptable conceptions are replaceable by more logically

acceptable scientific concepts. This presumption typifies the ‘cold’ model of conceptual change, which is based on the notion of conceptual replacement. As Zou (2012: 115) explains, this definition is predicated upon the premise that “science teaching should be an assimilation of students’ thinking into Western science-based school curriculum.” In turn, this view is based on the notion that Western science is “a universal form of knowledge that transcends cultural interpretation and is applicable to every corner of the world.” The consequence of this view is that, in practice, teachers push back learners’ life experiences and ethno-racial backgrounds into nothingness. Thus, in outlining the desired and expected achievements of science education, learners’ life experiences and locally-based knowledge are completely ignored. Unfortunately, even South Africa’s CAPS document (DBE, 2011: 11) embraces the notion that “what is today known as ‘science’ has roots in African, Arabic, Asian, European and American cultures.” From this premise, the DBE (2011: 11) takes the view that science “has evolved to become part of the cultural heritage of all nations.” Sadly, this view overpowers, dwarfs and vanquishes the position which the same DBE professes, that is, that the CAPS curriculum values indigenous knowledge systems.

The second perspective about conceptual change has been triggered by the fast-changing cultural composition of the science classroom, and the attendant need to socially and cognitively accommodate all learners. Zhou (2012: 115) refers to this as reflecting “multicultural trends in science education.” However, although this trend has been associated with the realisation that science teaching must accommodate the increasing diversity of learners in the classroom, there is no universal agreement about how this may be achieved. One viewpoint is that there should be a worldwide acknowledgement of an inherent universalism of Western science as the most powerful knowledge system in the world (Zhou, 2012: 115). Accordingly, despite learners’ diverse backgrounds, they should be compelled to accommodate Western science; that all what is needed is for the learners to develop pedagogical strategies and curricula that would facilitate their accommodation of Western science (Zhou, 2012: 116). In this regard, the inclusion of indigenous knowledge takes place within the context of an inherently Eurocentric science curriculum. According to Zhou (Zhou, 2012: 116), the problem with this perspective is that the justification for the inclusion of indigenous knowledge as part of the school curriculum lies in its

usefulness to, and compatibility with, Western science. Zhou explains this position further as follows:

It has been assumed that the degree of value depends on its translatability, that is, its removal from the original local, historical, and cultural context for relocation into the mainstream. In other words, most scholars in this group actually reiterate the universal idea of Western science, knowingly or unknowingly. (Zhou, 2012: 116).

Accordingly, the proponents of this supremacy model of Western Science look for compatibilities between multiculturalism in science education and the universal conception of science in a way that affirms the superiority of Western science over local alternatives (Zhou, 2012: 116). Thus, these two examples of multicultural conceptual change (that is, (a) compelling learners to accept Western Science as the dominant worldview, or (b) picking and choosing from local knowledge what is useful to, or compatible with, Western Science) fail to acknowledge that other forms of knowledge could be authentic and complete in, and by, themselves. For this reason, some scholars (e.g. Carter, 2008) argue for a more inclusive conceptualisation of science on the basis that, over the years, all cultures have systematically attempted to create their own understanding of the universe and their place within it; that local knowledge is also authentic (even if it may not be scientific) as it arose from local contexts in response to local needs. In the same vein, it is argued that Western science could also be “understood as a particular form of local knowledge tradition, shaped by and reproductive of, the culture and society in which it is articulated” (Carter, 2008: 175).

Overall, Zhou (2012: 115) concludes that although the above models imply and propose different ways of teaching for conceptual change, their purpose remains the same as the cold model: conceptual replacement model – insofar as they view the underlying goal of science teaching to be “an assimilation of students’ thinking into Western science-based school curriculum” and that Western science is “a universal form of knowledge that transcends cultural interpretation and is applicable to every corner of the world” (p. 115). In all these models, students’ life experiences

and ethno-racial backgrounds are largely overlooked when defining the desired achievements of science education.”

Zhou (2012: 117) makes a profound statement about learner preconceptions, and what teachers ought to be doing with regard to these preconceptions; that alternative concepts, in fact, represent an alternative science(s):

Student preconceptions are a product of their everyday culture plus traditional culture, both of which constitute their life-world culture. If we look at student preconceptions in a different way by changing ourselves from being an outside inspector with scientific ideas as judging criteria to being an insider of students’ real-life world, we will find that student preconceptions, although in many cases at odds with science, make sense to students themselves. Students’ preconceptions actually have a structure instead of being disconnected ... This is why student ideas have been called an alternative framework or science by some scholars ... It is important for us to consider this alternative science as one strong cultural factor when thinking of the goals and approaches of science education.

Zhou (2012: 111) observes that attempts to integrate students’ knowledge into school-based knowledge have been seen by some scholars as constituting some form of colonisation by way of “assimilating them into the culture of Western science.” However, although “a large volume of research over the last two decades of the 20th century has convincingly documented that students come into the classroom with their own ideas on many scientific topics ... efforts to replace students’ ideas with scientific notions have been reported to be very difficult in many cases” (Zhou, 2012: 111). The reason for this is that students experience a clash between their everyday traditional cultures, on one hand, and the scientific culture on another. Within the South African schools curriculum, the scientific culture defines the norms and conventions of thinking and behaving which the child must emulate. To this end, the curriculum compels the learners to accept and embrace the Western Science culture as the dominant and only authentic worldview, and that whatever they bring to the classroom is both irrelevant and inconsequential. To some degree, therefore, this study will establish how this affects children in the early days of

schooling. In the school system, acculturation takes the form of pressure being put on learners to abandon their prior (home) knowledge and understanding of the world around them and embrace school knowledge. However, for many years, it has been reported that learners' prior or home knowledge is stubbornly resistant to change (Driver, 1983; Wenning, 2008). In particular, Wenning (2008: 11) observes that "alternative conceptions are tenaciously held, and doggedly resistant to change."

Zhou advances four interrelated spaces as characterising the conditions under which the learners come in contact with school science:

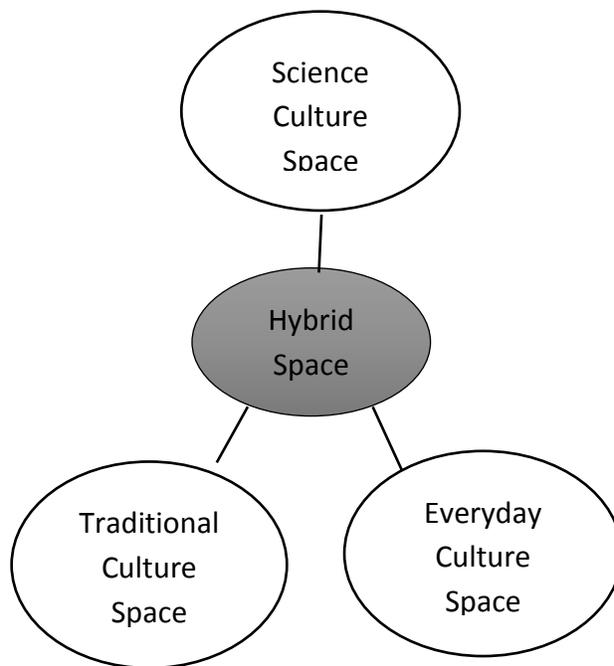


Figure 2.1: A hybrid space for science education [Source: Zhou, 2012: 117]

With reference to the relationships in Figure 1, Zhou (2012: 117) explains that "in today's context of globalization, science education actually takes place in a hybrid space of these three cultures: everyday culture, traditional culture, and scientific culture." However, it is important to note that this space does not represent a static and settled condition, but rather an unsettled, dynamic and ever-evolving quest for knowledge and understanding.

2.4 THE PEDAGOGY OF CONCEPTUAL CHANGE

The issue of conceptions, in respect to both learners and teachers has been a subject of intense research since the 1970s. As Treagust and Duit (2009: 90) point out “research on students’ and teachers’ conceptions and their roles in teaching and learning science has become one of the most important research domains in science education.” They further explain this point as follows:

The 1970s and early 1980s saw the growth of studies investigating the development of individual students’ pre-instructional conceptions towards the intended science concepts. From the mid-1980s onwards researchers became more interested in the social environment in which learning took place, leading to the notion of social constructivism. Many researchers investigating learning outcomes are interested in the notion of conceptual [P. 91] change, namely how individual conceptions change over time and, of particular interest, when these changes result in scientific understanding or understanding more closely related to the scientific conception. (Treagust and Duit, 2009: 90-91).

Concerning how the notion of conceptual change has affected teaching strategies, “the state of theory building on conceptual change has become more and more sophisticated, and the teaching and learning strategies developed have become more and more complex over the past 30 years” (Duit and Treagust, 2012: 50). Within the ‘instructional strategy’ literature, the word ‘strategy’ is not used in a consistent way “as a result of the different perspectives we have when exploring the social world, but also because this concept is a challenging one” (Riordan, 2014: 35). For some writers, strategy refers to something decided before the lesson, which does not change during teaching and to others it refers to a teacher’s overall plan that guides the sequencing of teaching within a particular topic, but could change during the course of a lesson (Scott, Asoko and Driver, 1991: 1). More recent research sees instructional strategies as interacting “with learner’s reasoning methods during lessons, in dynamic and often unpredictable ways” (Riordan, 2014: 35).

Riordan (2014: 36) draws a distinction between the ‘conflict and resolution’ strategies from a Piagetian tradition, versus strategies “which build on learners’ existing ideas and extend them”, which are attributable to Vygotsky. Accordingly, Riordan (2014: 37) identifies interactive engagement strategies (which typically include cooperative group problem solving), tutorials (which involve questions and exercises for students working in small groups), and interactive lecture demonstrations, as approaches which can produce significant learning gains by offering learners opportunities to discuss and change concepts while undertaking interesting activities and experiments. In all these approaches, the strategy is to introduce intellectual challenges to learners in the form of ‘cognitive conflict’ within the context of alternating cycles of small group and whole class work, in order to encourage metacognition and transfer of learning to other contexts. In this regard, Riordan (2014: 37-38) reports that there is evidence that these approaches enhance the cognitive development of children, and have resulted in substantial academic achievements for many learners.

In addition to the term ‘strategy’, some instructional strategists also use the term ‘tactic’ in reference to the ways a teacher endeavours to effect conceptual change among his/her learners. According to Riordan (2014: 37), the word ‘tactic’ comes from the Greek word (*taktike*) meaning ‘arrangement’, while the word ‘strategy’ comes from the Greek word (*stratēgia*) meaning ‘generalship’. The context of the origin of both terms is military, whereby “tactics is the theory of the use of military forces in combat. Strategy is the theory of the use of combats for the object of the War” (Clausewitz, 1832, in Riordan, 2014: 37). Thus, within the classroom, this brings forth the concept of ‘conceptual combat’ whereupon a learner is confronted with two or more conflicting concepts, and s/he must find ways to resolve the conflict. The notion of conceptual combat is what Riordan (2014: 39) refers to as the “Clausewitzian understanding of the nature of strategy”, which essentially opines that “strategy is neither a simple plan which will bring about conceptual change, nor a doomed endeavor” (Riordan, 2014: 41). As such, “Clausewitz saw the purpose of strategy to be the education of the mind rather than the discovery of fixed laws or principles” (Riordan, 2014: 42):

Earlier theorists aimed to equip the conduct of war with principles, rules, or even systems, and thus considered only factors that could be mathematically calculated (e.g.,

numerical superiority; supply; the base; interior lines). All these attempts are objectionable, however, because they aim at fixed values. In war everything is uncertain and variable, intertwined with psychological forces and effects, and the product of a continuous interaction of opposites. (Clausewitz, 1832, in Riordan, 2014: 42)

Therefore, with this in mind, Riordan (2014: 42) argues that it would be “unfair to release trainee teachers onto the battlefield of conceptual change in the science classroom without sharing with them something of how experienced science teachers work in this environment”, nor would it be fair “to expect even advanced skills science teachers to be able to articulate complicated educational strategy without the support of educational research.” Accordingly, Riordan contrasts the Clausewitzian perspective with the views of ‘optimistic’ versus ‘pessimistic’ strategists. According to Riordan (2014: 39-40), “optimists appear to understand strategy as a set of instructions employed to solve educational problems definitively” while “pessimistic strategists see no hope” in laying down any strategies – as reflected in the following quotation:

What science can there be in a matter in which, as in all practical matters, nothing can be defined, and everything depends on innumerable conditions the significance of which is determined at a particular moment which no one knows when? (Tolstoy, 1869, in Riordan, 2014: 40).

By not believing that there can be any strategies, or teaching methods, that will influence learning the pessimists leave practitioners without guidance (Riordan, 2014: 46-47). Indeed, their extreme view of abandoning the attempt to articulate the complicated interactions between learners and their teacher during a lesson would lead to disastrous and chaotic classroom environments.

To Vosniadou and Ioannides (1998: 1213) learning is a “gradual process during which initial conceptual structures based on children’s interpretation of everyday experience are continuously enriched and restructured.”

To this end, it has been reported that “the traditional approach of overcoming alternative conceptions consisting of eliciting, confronting, and resolving has not always been an effective way for teaching and learning physics as can be inferred from the results certain physics

education research” (Wenning, 2008: 14). For this reason, Wenning surmises that a five-step model, with two additional steps, would work better. He argues that “a poorly understood Elicit-Confront-Resolve approach fails to make a substantial lasting difference in the area of alternative conceptions because it fails to clearly *identify* the existence of the alternative conception to students and fails to *reinforce* student learning in the area of the alternative conception” (Wenning, 2008: 15). As such, he proposes the ECIRR (Elicit – Confront – Identify – Resolve - Reinforce) model, with an emphasis on identifying the alternative conceptions and reinforcing conceptual change in ways that are specific to the clearly identified alternative conception. Duit and Treagust (2012: 45) also contend that this approach “clearly has been the most influential perspective in the domain of conceptual change” (p. 45).

In general, the pre-eminence of cognitivism and constructivism as the dominant ‘theories of learning’ spurred research in the direction of both learner and teacher conceptions. The reason for this was that “generally, the ideas of constructivism helps explain how learners develop their understanding of scientific phenomena [by emphasizing] that knowledge is not received passively but is built up by the cognising subject and that the function of cognition is adaptive and enables the learner to construct viable explanation of experience” (Treagust and Duit, 2009: 90). The constructivist perspective of learning has had a concomitant effect on teaching approaches which were now also expected to “consider students’ beliefs and conceptions towards student-centred pedagogy in science instruction with the focus on the students, their interests, their learning skills, and their needs in actively constructing their knowledge” (Treagust and Duit, 2009: 90).

Thus, there have been several general approaches conceptualised and implemented over the past few decades with regard to pedagogies directed at ameliorating alternative conceptions and effecting conceptual change. These include a general class of strategies which appear to be inspired by the Piagetian perspective of learning based on the notion of disequilibrium. The strategies have had in common “the requirement that students encounter phenomena that run counter to their existing beliefs” (Wenning, 2008: 14). Thus, as Wenning (2008: 14) reports, by thrusting learners into “a state of intellectual disequilibrium or cognitive conflict” it was envisaged that such learners would become “aware of the conflict between what they believe to

be correct based on prior experiences and know to be correct based on more recent experience.” Accordingly, the learners would be forced to “confront and resolve their conflicting perspectives” in favour of what they have learnt from the most recent school experiences. According to Wenning (2008: 14), this general class of interventions includes learning cycles, conceptual change theory, bridging analogies, microcomputer-based laboratory experiences, disequibration techniques, an inquiry approach coupled with concept substitution strategies, metaconceptual teaching on inducing a particularly problematic aspect of the conceptual changes, and a teaching model.

Beeth, Duit, Prenzel, Ostermeier, Tytler and Wickman (2003) argue that conceptual change-based instructional methods need to improve teaching and learning of science. As such, they postulate that three things are needed, namely (a) supporting teachers to rethink the representation of science in the curriculum; (b) enlarging the repertoire of tasks, experiments and teaching and learning strategies and resources; and (c) promoting strategies and resources that attempt to increase students’ engagement and interests. In doing this, Beeth, et al. (2003) argue that following these three prescripts will ensure that the traditional science content structure is also subjected to some kind of change in order to accommodate the lived experiences of the learners; that more specifically, the teachers were sensitized to ensure that they made a conscious attempt to build the lesson development on the contributions of the learners. As Duit and Treagust (2012: 47) point out, “the content structure for instruction needs to be designed taking into account the actual knowledge of what we know about students’ pre-instructional conceptions and learning processes from conceptual change studies.” They further aver that instructional planning needs to “deliberately take into account the aims of instruction and the student cognitive and affective perspectives when planning content structure for instruction” (Duit and Treagust, 2012: 47).

The C³P Project Model

The above, notwithstanding, there has also been a second general strategy for ameliorating alternative conceptions. This was developed for a project known as the C³P Project, and involves seven steps as follows:

- a) must recognise that alternative conceptions exist;

- b) probe for student's alternative conceptions through demonstrations and questions;
- c) ask students to clarify their understanding and beliefs;
- d) provide contradictions to students' alternative conceptions through questions, implications, and demonstrations;
- e) encourage discussion, urging students to apply physical concepts in their reasoning;
- f) foster the replacement of the misconception with new concepts through (i) questions, (ii) thought experiments, (iii) hypothetical situations with and without the underlying physical law, and (iv) experiments or demonstrations designed to test hypotheses; and
- g) re-evaluate students' understanding by posing conceptual questions. (Wenning, 2008: 14).

However, not much information is available concerning the success rate of this approach.

2.5 COLLATERAL LEARNING THEORY

There is a view that the notion of conceptual change does not describe the learning experiences of indigenous people in the sense that learning for them is not continuous with Western science; that applying the notion of conceptual change to the learning experiences of indigenous communities in a Western curriculum is essentially tantamount to applying a wrong theory (Roth, 2008: 381). This is, therefore, the point of departure for defining and articulating collateral learning as a theoretical perspective distinguishable from conceptual change learning as described above. The main distinguishing feature of collateral learning takes on board both socio-cultural and conceptual change traditions, with an "adoption of a multiple perspective approach, emphasising the importance of discourse in teaching and learning, whereby the influence of subtle differences in the way people speak, how non-verbal communication like gesture, proxemics, gaze direction and rhythm must be included in analysis, and also put some insight into the pitfalls of misinterpretation" (Riordan, 2014: 27-28).

Collateral learning is evident when learners possess "at least two sources of knowledge to explain some science concepts" (Sutherland, 2005: 595). This may, in fact, be extended to having more than one epistemological and ontological knowledge source to explain events in one's lived world. Typically, the two sources of knowledge are (a) the espoused (official) school

science curriculum, and (b) home or day-to-day socio-cultural experience and perspective. For this reason, much research over the past few decades has focused on possible ‘interference’ of the latter (that is, home knowledge) in the attainment of the former. As Sutherland (2005: 595) observes, “there is a vast array of literature that explores the way in which the culture and language of an individual student influences how she/he may approach learning Western science.”

One of the main observations that has come out of this research is that there is a fundamental difference in the learning approaches to knowledge construction between Western science and most indigenous communities. Thus, whereas Western science “contains its own presuppositions about the nature of science, such as the idea that the universe can be understood through a series of theories and laws,” indigenous communities “may not necessarily understand nor subscribe to the Western science worldview” (Sutherland, 2005: 595-96). So, whereas “the study of Western science requires the student to have some understanding of the approaches Western science adopts in order to understand and explain the universe, specifically through theories, models, and laws,” (Sutherland, 2005: 596), such an approach may be irrelevant to an indigenous child. In fact, some learners resist Western science learning (Larson, 1995). The result of this is that the indigenous child may learn the ‘Western science’ theories and laws independently of his or her day-to-day socio-cultural experiences. Ultimately, the child ends up with two or more epistemological and ontological sources of knowledge and understanding of the world – of which the school knowledge is only one source.

According to Jegede (1997: 11), collateral learning manifests where “a learner in a non-western classroom constructs, side by side and with minimal interference and interaction, western and traditional meanings of a simple concept ... [which the learner] stores up in long-term memory with a capability for strategic use in either the western or traditional environment.” Therefore, the two collateral learning typologies that are the most important in understanding collateral learning in the classroom are the two at the extremes of the continuum, that is, parallel and secured collateral learning (refer to Figure 2.2).

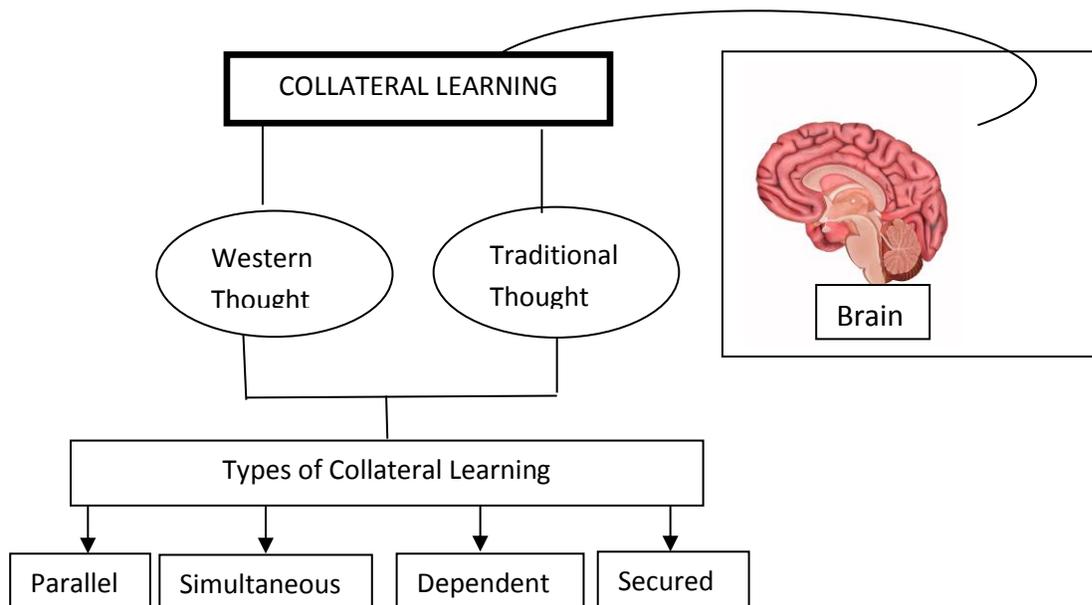


Figure 2.2: Collateral learning in human long-term memory. [Source: Jegede, 1997: 13]

The different types of collateral learning are not necessarily distinct from each other. They are not to be viewed as compartmentalized but rather as a continuum within the learning of science concepts in a socio-cultural framework within which a learner could be guided to progress from parallel, through simultaneous and dependent, to secured collateral learning (le Grange, 2007: 583). Going to the extreme end of the continuum, a secured collateral learner is one who is “capable of resolving a conflict between two ideas” such that he or she can “provide explanations for maintaining both ideas” or has resolved the conflict between the two ideas by creating “some form of convergence of the two ideas” (Sutherland, 2005: 599). As she further explains, “a secured collateral learner will produce ideas that may combine the science knowledge with their indigenous knowledge” (Sutherland, 2005: 599).

Accordingly, collateral learning is evident when two or more conflicting schemata are held simultaneously in long-term memory, but do not interact at all with one another (Jegede and

Aikenhead, 1999). So, what this means practically, is that “in the case of pursuing knowledge, the indigenous parallel collateral learner will switch between placing value on knowledge provided by obtaining information from a science textbook (in the school context) and the knowledge received from an experienced elder (in the context of the community)” (Sutherland, 2005: 599). Accordingly, between parallel and secured collateral learning, there is a variety of degrees of types of interactions between conflicting ideas.

In explaining this typology, Jegede states that parallel collateral learning is characterised as the compartmentalization technique of learning science, whereby conflicting ideas do not interact at all – such that learners “who are parallel collateral learners will access one idea over the other depending upon the context” (Sutherland, 2005: 599). Therefore, in the case of pursuing knowledge, the indigenous parallel collateral learner will switch between placing value on knowledge provided by obtaining information from a science textbook (in the school context) and the knowledge received from an experienced elder (in the context of the community). Secured collateral learning is at the other end of the continuum. Students are secured collateral learners when they are capable of resolving a conflict between two ideas. That is, they are able to provide explanations for maintaining both ideas or have created some form of convergence of the two ideas. Therefore, a secured collateral learner will produce ideas that may combine the science knowledge with their indigenous knowledge.

It should be stated, however, that Jegede’s collateral learning theory “does not presume that all aspects of a person’s worldview are in conflict with the worldview of Western science.” In fact, there are some shared characteristics between Western science and some aspects of indigenous knowledge, such that in the cases where the individual does not encounter any schematic conflict, he or she may adopt a learning strategy other than collateral learning (Sutherland, 2005: 600). As Cobern (1994) avers, “traditional culture poses no threat to logic and thus need not be viewed as an impediment to the learning of modern science.” Jegede’s theory only applies to the schemata that are in conflict.

In general, however, when a learner is subjected to a curriculum which has very little in common with his/her cultural background, the notion of acculturation surfaces. According to Schwartz, Unger, Zamboanga and Szapocznik (2010: 237), “*acculturation* refers to changes that take place as a result of contact with culturally dissimilar people, groups, and social influences.” In the school system, this takes the form of pressure being put on learners to abandon their prior (home) knowledge and understanding of the world around them and embrace school knowledge. However, for many years, it has been reported that learners’ prior or home knowledge is stubbornly resistant to change (Driver, 1983; Wenning, 2008). In particular, Wenning (2008: 11) observes that “alternative conceptions are tenaciously held, and doggedly resistant to change.”

Cross-cultural adaption is sometimes referred to as acculturation to describe “a wide spectrum of individuals’ possible responses to a new cultural context ranging from complete adoption to complete rejection of the receiving social values” (Lian, 2010: 83). In this regard, four strategies have been described as possible ways to deal with acculturation, namely **integration** (adopts the receiving culture and retains the heritage culture), **assimilation** (adopts the receiving culture and discards the heritage culture), **separation** (rejects the receiving culture and retains the heritage culture), and **marginalization** (rejects both the heritage and receiving cultures) (Berry, 1990, 1997; Berry and Sam (1997). From research it has been reported that integration is the best strategy for cross-cultural adaptation and marginalization should be the worst (Lian, 2010: 84).

There are parallels between the Berry model and Jegede’s four types of collateral learning (Jegede, 1997). Collateral learning theory is based on the recognition of “the multiplicity of cultures, each with its own worldview and each existing in its appropriate context” (Jegede, 1997: 11). Jegede, the father of collateral learning theory, describes four types of collateral learning, namely parallel, simultaneous, dependent and secured (see Figure 2.3). However, these four different types of collateral learning are not not necessarily distinct from each other – and should, therefore not “be viewed as a compartmentalized but rather as a continuum within the learning of science concepts in a socio-cultural framework within which a learner could be guided to progress from parallel, through simultaneous and dependent, to secured collateral learning.” (Jegede, in Sutherland, 2005: 599).

Herbert reports that in her study “students engaged in border crossing from traditional ways of knowing and everyday constructions to conventional science understandings, and that they engaged in secured, dependent, and parallel collateral learning.” This was attributed to the effectiveness of “the pedagogy of bridge-building [which] facilitated students’ entry into the western science world.” (p. 20). In explaining her findings further, Herbert had the following to say:

Firstly, it illustrates a way of thinking about science that fits in with the concept of autonomous acculturation. It is very different from thinking about science as the “superior,” only valid way of knowing--thinking that often underpins the scientism of many science curricula. Many students who are exposed to such science curricula often interpret science as attempts at assimilation and feel alienated from science ... It is likely that students’ interpretation that science is “the other half” may have fuelled their disposition to learn science. (Herbert, 2008:20)

She explained that the second reason for her findings was that “teachers of cross-cultural curricula should continuously engage participating students in discussion about their interpretations of their learning experiences ... [and] use the students’ interpretations as a guide to help them “to develop fuller understanding about different worldviews by focussing on the differences between them” (pp. 20-21). According to Herbert, the value of this autonomous acculturation approach in which the traditional worldview is not threatened by the Western science world view lies in the disposition it creates to engage in fuller and more open discussions, which could, *inter alia*, centre around the “the differences in philosophical underpinnings and in underlying values, and also on the role and purposes of each knowledge system in mediating people’s understanding of themselves and their relationship to their environment.” Herbert, 2008:21). Herbert concludes her explanation of the effectiveness of this approach by stating as follows:

Such discussions may lead students to construct other types of relations between western science and traditional practices and beliefs that are different from “the other half.” For example, in-depth discussions may allow students to discern the relationship between the worldviews as “different wholes,” and could simultaneously facilitate border-crossing.

Singh and Reyhner (2013: 37) hold the view that globally, educational systems have failed Indigenous students with regard “to both respecting their human rights, including providing academic success, and as a result, Indigenous students around the world have demonstrated a lack of academic achievement and enthusiasm for schooling in its conventional colonial form.” Thus, there is a call for a culturally responsive pedagogy which “entails embracing and celebrating individual differences, providing culturally relevant learning experiences, helping all students develop positive self-concepts, and having high expectations for all regardless of cultural background.” (Hamza and Hernandez-de Hahn (2012: 76).

2.6 CONCEPTUAL FRAMEWORK

According to Monteiro (2015: i) research acknowledges that if students are to be successful in science “they must learn to navigate and cross-cultural borders that exist between their own cultures and the subculture of science.” For this reason, Monteiro (2015: 1) contends that “teachers must learn to capitalize on the diversity that exists in their classrooms and apply it to their science instruction in culturally appropriate ways.” Indeed, according to collateral learning science teachers must function as “pedagogical culture workers who make the culture of science accessible to all their students” (Aikenhead and Jegede, 1999: 271), by assisting them to “mediate or negotiate cultural border” (le Grange, 2007: 588); they need to facilitate the border crossing for their learners. So, in order to perform their duty of making the culture of science accessible to their learners, science teachers need to know the level of difficulty their learners are experiencing in attempting to cross the border from their everyday knowledge and understanding to the culture of science. This involves transitioning learners by scaffolding them and moving them from parallel to simultaneous, to dependent and then secured collateral learning, as “a *tour guide* cultural broker and in other instances a *travel agent* cultural broker” (le Grange, 2007: 588). In le Grange’s view (p. 588), “scaffolding learners through parallel and simultaneous collateral learning would require the teacher to play the role of tour guide, whereas scaffolding learners through/from dependent learning to secured collateral learning might require the teacher to chiefly take on the role of travel agent” (p. 588). Nonetheless, “both approaches assume that learning/teaching occurs within a *science content* ecocultural paradigm.

Using the analogy of the teacher as a tour guide, Le Grange (2007: 588) states that “when cultural border crossing (from life-world culture to school science culture) is difficult for the learner, the teacher needs to take on the role of a tour guide, whereby the teacher takes learners to the principal sites in the culture of science and coaches them on what to look for and how to use it in their everyday lives,” using an extended repertoire of methods (le Grange, 2007: 588). He further explains as follows:

In other instances where learners require less guidance when border crossing, the teacher may take on the role of travel agent, whereby the teacher provides learners with incentives such as topics, issues, activities or events that create the need to know the culture of science. In other words, border crossing occurs through academic bridges and less through guidance.”

Aikenhead and Jegede (1999: 271) contend that “the construct of cultural border crossing is grounded in empirical research and warranted in the anthropological paradigm.” They explain this point as follows:

From the viewpoint of cultural anthropology, to learn science is to acquire the culture of science ... To acquire the culture of science, students must travel from their everyday life-world to the world of science found in their science classroom. Students’ flexibility, playfulness, and feelings of ease in the world of science will help determine the smoothness with which students cross the border into the culture of science. This smoothness will likely affect the degree of culture acquisition that takes place. (Aikenhead and Jegede (1999: 274).

In this regard, science teachers need to ascertain the extent of the hurdle facing the learners. Fakudze (2004: 271) explains the various categories of border crossing as follows:

Smooth border crossing occurs when the students' worldviews are congruent with school science. *Managed* border crossing occurs when the students' worldviews are different from the science worldview thus requiring the transition from one to the other to be managed. *Hazardous* border crossing occurs when the students' worldview and scientific

worldview are rather diffused leading to hazardous transitions from one worldview to the other. *Impossible* border crossing occurs when the students' worldview and that of science are highly discordant causing the students to resist transitions from one worldview to the other. [Emphasis added].

Accordingly, smooth border crossing happens “when the culture of science generally harmonizes with a student’s life-world culture, science instruction will tend to support the students’ view of the world, and the process of enculturation tends to occur” (Aikenhead and Jegede, 1999: 274). However, where the cultural border crossing is hazardous, or very difficult, learners will exhibit barriers to learning. Aikenhead and Jegede (1999: 274) explain this situation as follows:

When the culture of science is generally at odds with a student’s life-world, science instruction will tend to disrupt the student’s worldview by trying to force that student to abandon or marginalize his or her life-world concepts and reconstruct in their place new (scientific) ways of conceptualizing. This process is assimilation. Assimilation can alienate students from their indigenous life-world culture, thereby causing various social disruptions ... or alternatively, attempts at assimilation can alienate students from science, thereby causing them to develop clever ways (school games) to pass their science courses without learning the content in a meaningful way assumed by the community.

In many instances, the transition from learners’ everyday culture to the school culture is a tall order for the majority of learners. As such, learning science becomes a matter of survival driven by the shame of failing (known in Educational Psychology as ‘fear of failure’), so they succumb to learning science through assimilation. As Aikenhead and Jegede (1999: 275) explain:

For a large majority of students, science teaching is experienced as an attempt to assimilate them ... A vast array of science education research into students’ construction of scientific concepts concludes that most students exhibit creativity and intransigence in their quest to circumvent the construction of scientific concepts ... In other words, many

students try to circumvent assimilation and at the same time avoid expending unnecessary effort.

Working with the concept of learning as navigating transitions between borders, Costa (in Monteiro, 2015: 7) developed a typology consisting of five categories of students with regard to how they navigate “transitions between their worlds of family, peers, and school and the connections between these transitions and the students’ success in the science classroom.” Depending on the category a student falls under, the challenge of crossing over to the sub-culture of school science from the traditional and / or everyday culture(s) may be smooth or quite daunting – resulting in the learners performing quite differently in science.

The metaphor of border crossing has been used to illustrate students’ cultural transitioning from their traditional and everyday cultures, on one hand, to the school science, on another (Aikenhead, 1996; Aikenhead and Jegede, 1999). Zhou explains the phenomenon of border crossing as follows:

This metaphor announces that people must cross borders as they move from one culture to another. It reflects the uneasiness and struggles that students have to face when coming to the science classroom. It also signals that students may have different experiences when they cross the border due to their varying cultural backgrounds and personality factors.

Table 2.4 summarises the five typologies, their descriptions and the likely state of transitioning across the traditional/everyday culture to the school science sub-culture.

Table 2.4: Costa’s Five Typologies Defining Cross-Cultural Transitions

NO	TYPOLOGY	DESCRIPTION
1	Potential	Worlds of family and friends are congruent with worlds of scientists both school and science - transitions are smooth.
2	Other smart kids	Worlds of family and friends are congruent with world of school but inconsistent with world of science – transitions are manageable
3	I don’t know	Worlds of family and friends are inconsistent with worlds of

	students	both school and science – transitions tend to be hazardous.
4	Outsiders	Worlds of family and friends are discordant with worlds of both school and science – transitions are virtually impossible
5	Inside outsiders	Worlds of family and friends are irreconcilable with world of school but potentially compatible with world of science – transitions are frustratingly difficult. [<i>Source</i> : The researcher]

In interpreting these categories, Aikenhead and Jegede (1999: 184) point out that whereas “the first four categories represent degrees of ease at crossing cultural borders into school science” the fifth one “arose from abject discrimination against some students by the school.” Thus, in reflecting on these typologies Aikenhead and Jegede (1999) surmised that:

cultural transitions are smooth when the cultures of family and science are congruent, transitions are manageable when the cultures are somewhat different, transitions tend to be hazardous when the cultures are diverse, and transitions are virtually impossible when the cultures are highly

The notion of learning being inter-dependent between the individual learner and some form of ‘social agency’ resonates closely with Vygotsky’s theory of the Zone of Proximal Development (ZPD) (Vygotsky, 1978). According to the ZPD, social interaction plays a fundamental role in the process of cognitive development. During this social interaction, the ‘more knowledgeable other’ – that is, anyone who has a better understanding or a higher ability level than the learner, with respect to a particular task, process, or concept, guides the learner towards being able to solve a particular problem independently. In this regard, the ‘more knowledgeable other’ could be a teacher, coach, older adult, peer, a younger person, or even a computer programme.

The ZPD is the distance between a learner’s ability to perform a task under the guidance of the ‘social agent’, or with peer collaboration, and his/her ability to solve the problem independently. Schematically this may be represented as in Figure 2.3.

In this illustration, the ZPD lies in the area between what a learner can do without any help or assistance and what he/ she is unable to achieve even with support and help. It is in the area, when a learner is just outside of what he or she already knows and what he/she is comfortable

doing, that Vygotsky theorised the most engagement and learning would occur. Thus, the ZPD is the difference between a learner’s actual developmental level and his or her current potential development. Accordingly, activities which are too easy for the learner are likely to become boring quickly, and those which are too difficult are likely to be difficult for him/her to engage with – even when with help and support. In this regard, two reasons why the instructional process may fail to achieve its intended learning outcomes are that the intended learning outcome falls outside the ZPD, or the intended learning outcome falls within the ZPD but the required support is not provided.

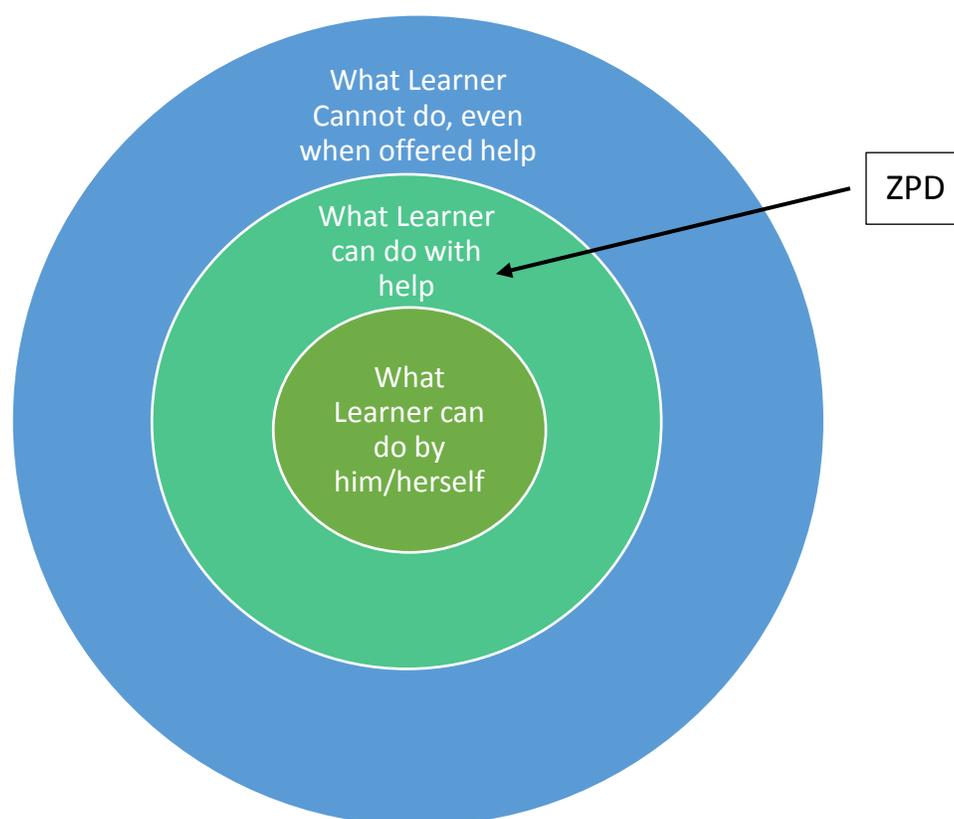


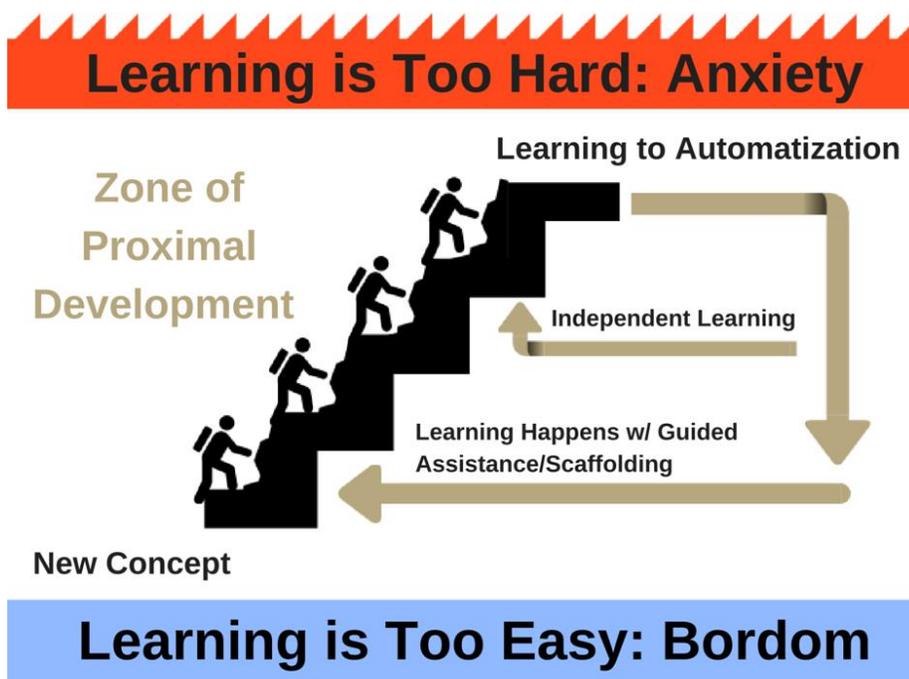
Figure 2.3 Zone of Proximal Development (ZPD). [Source: The researcher]

So, from Vygotsky’s perspective, “the teacher’s role is mediating children’s learning activities as they share knowledge through social interaction” within the Zone of Proximal Development (Dixon-Krauss, 1996: 18). The ‘sharing of knowledge through social interaction’ is done within the notion of scaffolding, whereby the ‘more knowledgeable other’ provides support to the

learner until such time that the learner can stand on his / her own feet. Warren (2016: 1) explains this phenomenon as follows:

Then, as learning happens, the support structure is slowly pulled away. Eventually, students engage in independent learning and practice until they reach automatization. Learning to automatization means that one has fully learned a concept to mastery and the process of completing a problem is virtually automatic and requires little to no thought.

Therefore, scaffolding is a key aspect of Vygotsky's concept of effective teaching, which may include modelling a skill, providing hints or cues, and adapting material or activity. The notion of scaffolding may be illustrated as in Figure 2.4:



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Figure 2.4: The Notion of Scaffolding

Figure 2.4 shows that within the ZPD, a learner initially requires support (scaffolding) to enable him / her scale the journey from the space where he/she finds things to be too easy to where things may be too difficult without help. Gradually, the level of support provided is lessened

until the learner is able to work independently with regard to the material in question. The four basic steps involved here are presented in Figure 2.5:

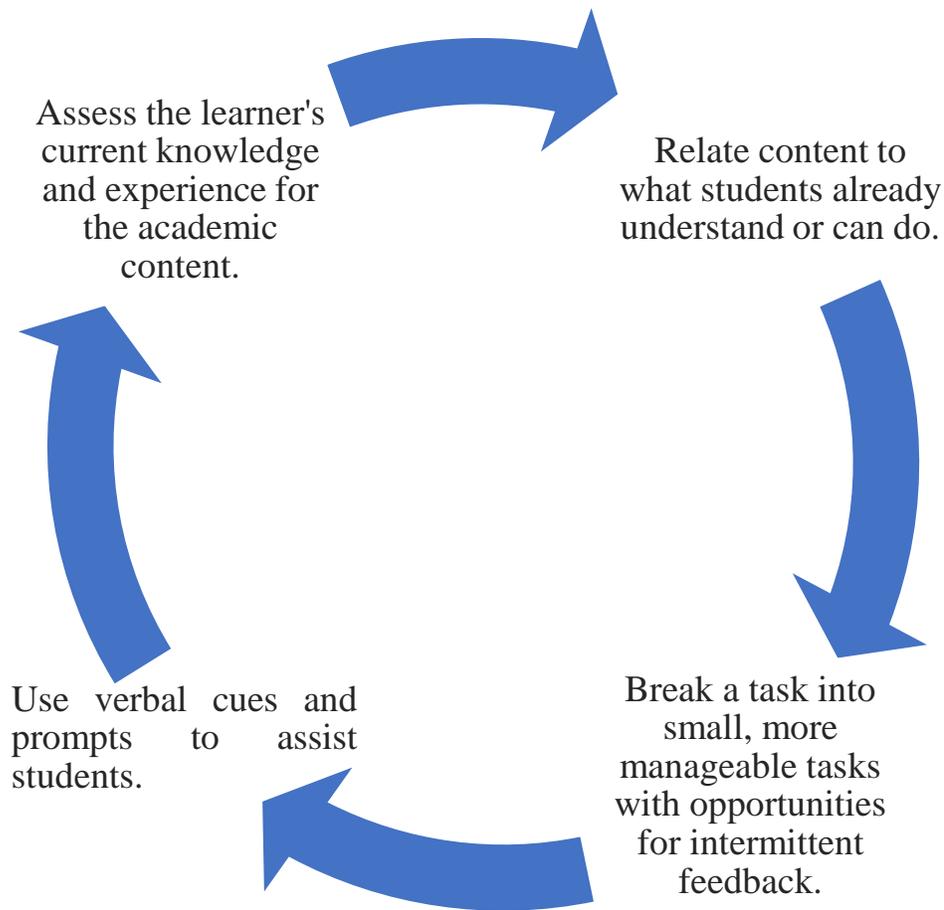


Figure 2.5: Four basic steps in Vygotsky's teaching approach. [Source: The researcher]

In using the ZPD model, teachers should structure learning activities in such a way that the learner functions between the baseline and ceiling of his or her capacity. In doing so, particular attention should be paid to the connections between people and the sociocultural context in which they act and interact in shared experiences. Vygotsky (1978) explains that humans use tools that develop from a culture, such as speech and writing, to mediate their social environments; that initially children develop these tools to serve solely as social functions, ways to communicate their needs – and that subsequently, the internalisation of these tools leads to higher thinking skills. Thus, in applying this view to schooling, Vygotsky maintains that

whereas many schools have traditionally held a transmissionist or instructionist model of teaching in which a teacher ‘transmits’ information to a learner, a more appropriate approach would be one where the traditional roles of the teacher and learner are shifted – such that the teacher collaborates with his or her learners in order to help facilitate *meaning construction* in individual learners. Accordingly, Vygotsky’s theory promotes learning contexts in which learners play an active role in learning. The theory also feeds into current interest in collaborative learning, on the basis that group members will possess different levels of ability, such that the more advanced peers will help less advanced members of the group, operating within their zone of proximal development.

Table 2.5 juxtaposes Costa’s cross-cultural transitions with the border-crossing categories advanced by Aikenhead and Jegede (1999).

Table 2.5: Costa’s Five Typologies Juxtaposed with the Border Crossing Typology

NO	TYOLOGY	DESCRIPTION	AIKENHEAD / JEGEDE TYOLOGY
1	Potential scientists	Worlds of family and friends are congruent with worlds of both school and science - transitions are smooth.	<i>Smooth</i> border crossing
2	Other smart kids	Worlds of family and friends are congruent with world of school but inconsistent with world of science – transitions are manageable	<i>Managed</i> border crossing
3	I don’t know students	Worlds of family and friends are inconsistent with worlds of both school and science – transitions tend to be hazardous.	<i>Hazardous</i> border crossing
4	Outsiders	Worlds of family and friends are discordant with worlds of both school and science – transitions are virtually impossible	<i>Hazardous</i> border crossing
5	Inside outsiders	Worlds of family and friends are irreconcilable with world of school but potentially compatible with world of science – transitions are frustratingly difficult. [<i>Source</i> : The researcher]	<i>Impossible</i> border crossing

Table 2.5 highlights the complementarity and similarities between the two typologies. This information is illustrated in Figure 2.6, which also integrates Vygotsky’s ZPD into the model to

show which cross-cultural transitions and border-crossing categories can be scaffolded to result in potentially successful learning experiences.

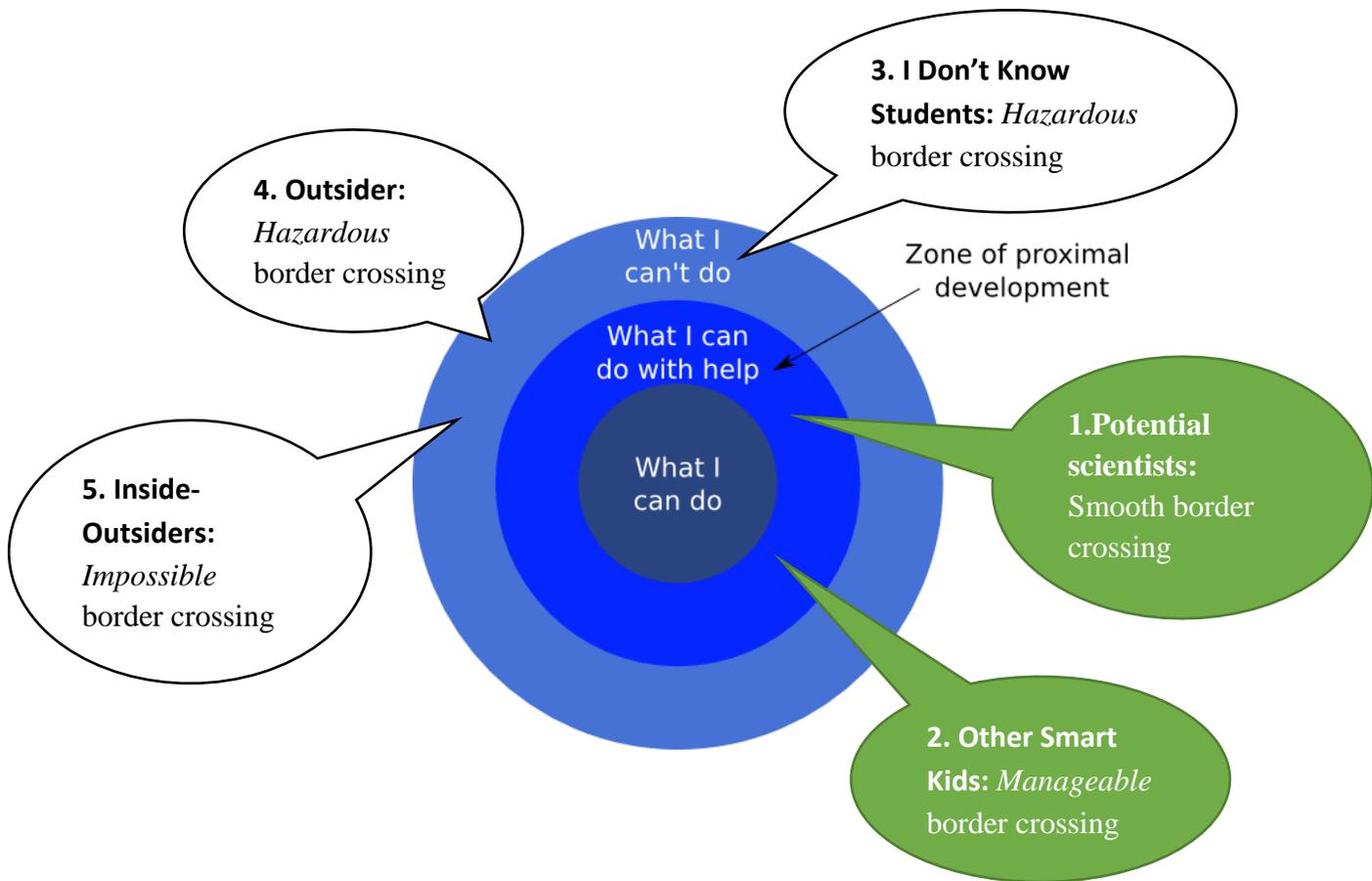


Figure 2.6: Integrated Model of cross-cultural transitions and border-crossing [Source: The researcher].

In Figure 2.6, there are two cross-cultural transitions and border-crossing categories which fall under the ZPD. Learners falling under these two classifications are the ones that could be scaffolded towards meeting the espoused learning outcomes. On the other hand, learners falling under Costa's categories 3 to 5, will find it either *hazardous* or *impossible* to transition towards the espoused learning outcomes because their academic preparedness at a level which falls outside the ZPD.

In essence, the influence of culture and other social conditions and circumstances on a person's cognition is what distinguishes Vygotsky's brand of constructivism from, say, Piaget's model which focuses almost exclusively on a person's interaction with his/her inert physical environment. In comparison, Vygotsky (1978) is credited with developing the concept of Social Cognition, commonly referred to as the Social development Theory of Learning, which professes that (a) social interaction and culture significantly influence cognitive development, (b) cognitive processes, such as language, thought and reasoning develop through social interaction, and (c) learning is largely mediated by social interaction between learners and the 'more knowledgeable other', who could be a teacher, parent, coach, a peer or any other expert. As Vygotsky and Luria (1930, quoted in Wells, 1999: 5) aver, "in child development, along with processes of organic growth and maturation, a second line of development is clearly distinguished – the cultural growth and thinking."

2.7 CONCLUSION

This chapter has presented a review of literature pertinent to the three research questions to be addressed in this study. The Review started with an overview of the urgent and quite important issue of a healthy environment, against the devastating effects of the human civilisation plundering Planet Earth. This was followed by a look at some studies which have reflected on the views and perceptions of learners about the notion of a healthy environment. This literature prepared the way to look at the various perspectives about conceptual change as well as the collateral learning theory – and how both affected teaching and learning strategies. Elements of these perspectives were then added to Vygotsky's theory to consummate a conceptual framework for this study. To this end, the researcher believes that she has made a reasonable and sufficient attempt at creating a good theoretical foundation for this study. What follows is chapter three, which describes the research methods and methodologies followed in data collection, interpretation and analysis.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter presents the methods and methodologies followed in addressing the research questions of this study which are hereby restated for ease of reference:

- What conceptions do grade three learners have of the construct of a healthy environment?
- What explanations lie behind the learners' conceptions of a healthy environment?
- Will there be a statistically significant difference in learner achievement between those taught through a cognitive conflict-based conceptual change approach versus those taught through an instructional approach based on Collateral Learning Theory?

The chapter presents and discusses the research paradigm adopted, research designs (one quantitative and another qualitative), target population and sampling techniques for the selection of participants, instrumentation and validation thereof, the theoretical bases for the interventions and the interventions themselves, data collection process and procedures, data analysis techniques employed and some ethical considerations.

3.2 RESEARCH PARADIGM

Against the perceived dominance of positivism as *the way of knowing* the 1908s witnessed a spirited debate on the appropriate philosophical and methodological foundations of social science research, out of which emerged alternative 'ways of knowing' – that is, alternative to positivism. Methodologically, positivism relied on quantitative research data, with notions of

objectivity which ruled out the influence of the actively thinking and speculative researcher on the outcome of scientific investigations. However, social science researchers questioned the relevance and appropriateness of the foundational assumptions of positivism to research in the social sciences – such as the positivism’s pursuance of the truth through, mainly, establishing causality – with the attendant assumption that ‘real causes exist’; that the natural world revolved around objective realities and regularities which could be determined accurately in a manner that ruled out human bias. The disenchantment with positivism led to a call for a ‘paradigm’ shift, which resulted in a plethora of research orientations – including the naturalistic, humanistic, ethnographic, historical, enchanted research approaches, as well as the ascendancy of critical theory, semiotics, literary explanation, existential-phenomenological, relativism/constructivism, and critical relativism (Hunt, 1991: 32). Thus, qualitative research is sometimes also referred to in the literature as “naturalistic, emergent, interpretive, phenomenological, hermeneutic, critical, or ideological” and is also associated with specific research perspectives, such as “ethnography, case study, grounded theory, and discourse analysis” (Angen, 2000: 379).

The term ‘paradigm’ refers to a research philosophy, encompassing a set of assumptions about the world and the nature of knowledge. To Rubin and Babbie (2011: 626), a paradigm is “a model or frame of reference that shapes our observations and understandings” (which shows Kuhn (1970) opines that a paradigm is a set of values and techniques which acts as a guide, dictating the kinds of problems researchers should address in a study, as well as the types of explanations and solutions that are acceptable to solve the identified problems (Kuhn, 1970-175). Mack (2010) envisages that a research paradigm is a “loose collection of logically related assumptions, concepts or propositions that orientate research and researcher’s thinking.” Kumar (2011) explains that the purpose of a research paradigm is to determine the mode of enquiry that is employed in carrying out a particular study. In this regard, Kumar (2011) asserts that to apply one approach extensively to all the research problems can be misleading and inappropriate. Creswell (2014) defines paradigm as a system of beliefs or world view that guides a study, including the research methodology that would need to be considered in order to realise the study’s objectives and addresses the research questions. One way to say this is that a particular researcher’s research paradigm will direct the researcher’s choice of data or information needed to address his/her research questions.

Wahyuni (2012) identifies four research paradigms, positivism, postpositivism, interpretivism and pragmatism. She uses four constructs to characterize, define and explain what each of these research paradigms – namely, **ontology** (the researcher’s assumption about the nature of knowledge), **epistemology** (how knowledge develops), **axiology** (the ethics and values held by the researcher), and **methodology** (the model for the process of undertaking the research). Accordingly, Wahyuni (2012) opines that ontologically both *positivism* and *postpositivism* , apply the *lens* of natural science to social science. Ontologically, they share a common view that social reality is external to the researcher and is objective in such a way that the researcher and the researched are separate entities. Epistemologically, both advocate for the use of the scientific approach by developing numeric measures to generate acceptable knowledge. This process of knowledge-making commences with the test of a theory in the form of hypotheses and involves statistical testing. s in their research process, although they.

However, positivists and postpositivists work from different philosophical assumptions, and differ from each other in that the former (positivists) seek to obtain law-like generalisations which they take to be universally applicable across various contexts, and believe that different researchers observing the same factual problem will generate similar results by carefully using statistical tests and applying a similar research process in their investigations. On the other hand, although believing in generalisation, postpositivists challenge the belief in the existence of the “absolute truth, especially in relation to studying human behaviour in social science” (Wahyuni, 2012: 71).

Wahyuni (2012: 71) goes further and explains that interpretivists “believe that reality is constructed by social actors and people’s perceptions of it.” Accordingly, interpretivists “recognise that individuals with their own varied backgrounds, assumptions and experiences contribute to the on-going construction of reality existing in their broader social context through social interaction.” Thus, because noting that human perspectives and experiences are subjective, interpretivists contend that social reality may change and can multi-faceted – thereby rejecting

positivists' notion of a singular truth and the objectivity of knowledge. Therefore, Wahyuni (2012: 71) explains the interpretivists' epistemological point of view as follows:

To understand the social world from the experiences and subjective meanings that people attach to it, interpretivist researchers favour to interact and to have a dialogue with the studied participants. They also prefer to work with qualitative data which provides rich descriptions of social constructs. As opposed to generalisation or the nomothetic approach adopted by postpositivist researchers, interpretivists use a narrative form of analysis to describe specifics and highly detailed accounts of a particular social reality being studied, which is termed the idiographic approach.

Wahyuni's fourth research paradigm is pragmatism, which "refuses to join the 'paradigm war' between the positivist and interpretivist research philosophies" (Wahyuni, 2012: 71). So, "Instead of questioning ontology and epistemology as the first step, pragmatist supporters start off with the research question to determine their research framework" – thereby emphasizing that "one should view research philosophy as a continuum, rather than an option that stands in opposite positions" (Wahyuni, 2012: 71). Thus, in capturing the essence of pragmatism, Wahyuni (2012: 71) states as follows:

Pragmatism believes that objectivist and subjectivist perspectives are not mutually exclusive. Hence, a mixture of ontology, epistemology and axiology is acceptable to approach and understand social phenomena. Here, the emphasis is on what works best to address the research problem at hand. Pragmatist researchers favour working with both quantitative and qualitative data because it enables them to better understand social reality.

Nonetheless, presently, it is generally accepted that the two dominant research paradigms are the quantitative and qualitative orientations to 'ways of knowing' (Johnson, Onwuegbuzie and Turner, 2007). Kumar (2011) prefers to refer to these two research orientations as positivism and interpretivism, respectively. Positivist researchers develop knowledge based on making careful observations and measuring aspects of an objective reality (Creswell, 2014:36), in a way that de-emphasises or eliminates the individual perceptions of the researcher. For positivists, only the phenomena that can be observed and measured objectively through numeric quantities

are considered valid knowledge. Typically, this is associated with laws or theories that need to be tested and refined through observation and measurement (Al-harbi, 2010). Thus, the positivist researcher starts his/her investigation with a theory or hypothesis, collects data and finally determines whether or not the data support or contradicts the theory or hypothesis. This is commonly referred to as the hypothetico-deductive model (Flyvbjerg, 2006). According to Sousa, Driessnack and Mendes (2007: 503) “a research design is the framework or guide used for the planning, implementation, and analysis of a study.”

On the other hand, interpretivism is largely qualitative in nature, and holds the view that reality is subjective and multiple (Creswell, 2014:37). Thus, an interpretivist researcher believes that people constantly seek to understand the world they live and work in – and they do so through their own contextually-based individual perceptions and views, which may lead to understandings, behaviours and unpredictable actions (Khan, 2014). Silverman (2004: 349) presents four claims of the value of qualitative research as (a) enabling researchers to study what people are doing in their natural context, (b) being flexible, (c) allowing researchers to study processes as well as outcomes, and (d) enabling researchers to explore meanings as well as causes of observed phenomena. According to Babbie and Mouton (2001: 221), qualitative research (a) aims to provide an in-depth description and understanding of events, (b) seeks to understand social action in terms of the specific context rather than to generalise findings to some theoretical population, and (c) is conducted in the natural setting of the social actors concerned. Accordingly, varied and manifold meanings are built as the researcher interacts with the world, which subsequently leads him/her to look for the complexity of situation being studied rather than narrowing it into a few ideas or experiences of the participants. So, interpretive researchers use various methods to study how individuals perceive and understand their lived-worlds by collecting non-quantitative data, using qualitative research method such as participant or direct observations, open-ended questions and interviews which allow participating individuals to share their views of the situation being investigated (Creswell, 2014:38).

Overall, it may be said that positivism represents the long-standing traditional form of research mostly followed in the natural sciences, characterised by the collection of empirical data through a definite sequence of steps commonly referred to as the scientific method. On the other hand,

interpretivism represents the research approaches that emerged as alternative to positivism, and are generally based on the collection and interpretation of non-quantitative data. However, Johnson, et al., (2007) posit that the synthesis of qualitative and quantitative research methods in a single study constitutes a third research paradigm. They aver that the advantage of *mixed methods* in a single study is that it often provides the most informative, complete, and balanced presentation of research results than using either approach alone. Thus, the use of *mixed methods* provides for data triangulation, expansion and generalization of findings, as well as more informative and reasonable interpretations (Creswell, 2014).

In their own words, Johnson, et al (2007: 129) proclaim this view as follows:

Mixed methods research is an intellectual and practical synthesis based on qualitative and quantitative research; it is the third methodological or research paradigm (along with qualitative and quantitative research). It recognizes the importance of traditional quantitative and qualitative research but also offers a powerful third paradigm choice that often will provide the most informative, complete, balanced, and useful research results.

Roth and Mehta (2002) are of the view that blending qualitative and quantitative research paradigms may in fact be a good thing in furthering the interests of both research orientations. In this regard, they aver that “not only may versions of positivism and interpretivism be combined in the analysis of contested events, but this combination can further the goals of both approaches by contributing information that may have been missed by adopting only one perspective.” The reason for this is that looking at a research problem only from one research paradigm may not bring out all the essential aspects of the problem being investigated; that each will, therefore, benefit from data that may emerge through the application of the data gathering techniques of the other research paradigm. Herein, therefore lies the power and efficacy of the mixed methods research paradigm. For Giddings and Grant (2007: 57) combining qualitative and quantitative methods could have a number of benefits, including “a broader research focus and a wider variety of data collection approaches which in turn enable richer descriptions of a phenomenon to be gathered.”

Although the *mixed methods* research design is not new, it represents a new movement seeking to formalize “the practice of using multiple research methods” (Johnson, Onwuegbuzie and Turner, 2007: 113). Johnson, *et al* further report that in the history of the development of research methods, this research design was first associated with the term *multiple operationalism*, as far back as the 1950s. Later the term ‘triangulation’ was coined – which is defined by Denzil (in Johnson, et al, 2007: 114) as “the combination of methodologies in the study of the same phenomenon”. Johnson, et al (2007: 117) sum it all up in their observation that “antagonism between paradigms is unproductive”. To Johnson and Onwuegbuzie (2004), mixed methods research is the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study or set of related studies.

For this study, the researcher adopted a mixed-methods research paradigm – that is, a combination of the positivist/quantitative and post-positivist (interpretivism/qualitative) research paradigms in line with the advantages and benefits which identified by Johnson, *et al.*, (2007) and Creswell (2014). More specifically, Creswell (2014: 289), reports that the use of mixed methods is associated with five purposes, namely, seeking convergence (triangulation), examining different facets of a phenomenon (complementarity), using the methods sequentially (development), discovering paradox and fresh perspectives (initiation), and adding breadth and scope to a project (expansion). They also found that the studies varied in terms of the assumptions, strengths, and limitations of the method and whether they addressed different phenomena or the same phenomena; were implemented within the same or different paradigms; were given equal or different weight in the study; and were implemented independently, concurrently, or sequentially.

More fundamentally, Aliyu, Singhry, Adamu and Abubakar (2015: 4-11) present the ontological, epistemological, axiological and methodological assumptions related to the quantitative (based on positivism) and qualitative (based on post-positivism) research paradigms. Table 3.1 summarises the essential attributes of these two research paradigms – suggesting that the mixed-methods research paradigm adopted in this study drew its benefits from each one of the two dominant research paradigms – and was based on a combination of the assumptions itemised in Table 3.1.

Table 3.1: The comparative aspects of the positivist versus post-positivist paradigms

	QUALITATIVE / POST-POSITIVIST	QUANTITATIVE / POSITIVIST
<p>Core ontological assumptions (Nature of Reality)</p>	<ol style="list-style-type: none"> 1. Reality is a projection of human imagination – and that reality is, therefore, subjective inasmuch as people experience reality in different ways 2. No single reality or any objective entity can be described in any objective way without human influence 3. The world is complex and dynamic and is constructed, interpreted and experienced by people in their interactions with each other and with wider social systems 4. Reality can only be imperfectly grasped 5. The use of language defines a particular reality 	<ol style="list-style-type: none"> 1. An objective, true reality exists which reflects absolute and universal truths – governed by unchangeable natural cause-effect laws, which can be discovered. 2. Reality is neither time nor context-bound

<p>Basic Epistemological Stance (Nature of Knowledge)</p>	<ol style="list-style-type: none"> 1. Knowledge is based not only on observable phenomena, but also on people’s subjective experiences, beliefs, values, reasons and understandings 2. Knowledge is constructed by people, and not handed down by a supernatural being 3. Knowledge is about the <i>way</i> in which people make meaning in their lives, not just <i>that</i> they make meaning, and <i>what</i> meaning they make 	<ol style="list-style-type: none"> 1. Knowledge is derived from objective processes and procedures. 2. Knowledge can be described in a systematic way 3. Knowledge consists of verified hypotheses that can be regarded as facts or laws. 4. Probabilistic – i.e. holds true for large groups of people or occurs in many situations 5. Knowledge is accurate and certain
<p>Axiological Assumptions (Underlying values and beliefs about knowledge)</p>	<ol style="list-style-type: none"> 1. Belief that values are an integral part of social life; that no values are wrong – only different 2. That knowledge claims can never be isolated from people’s values and beliefs 3. That values and beliefs of the researcher not only influence but, indeed, enrich his/her work 	<ol style="list-style-type: none"> 1. Research findings represent truths. 2. Values and personal beliefs have no place in authentic knowledge, so all bias must be eliminated in the process of knowledge-making
<p>Research Methods</p>	<ol style="list-style-type: none"> 1. Exploration of pure subjectivity 2. Use of unstructured observation instruments – interviews, questionnaires, observation protocols, etc. 3. Discourse, thematic, analysis 4. Investigator tries to capture “insider” knowledge and understanding 5. Uses participatory action research; dialogical methods, which encourage dialogue between researcher and researched 6. Data collected mainly from field research, conducted in natural settings in order to collect substantial situational information 7. The investigator is a co-creator of meaning, working actively with the researched 8. Both the investigator and the 	<ol style="list-style-type: none"> 1. Empirical, laboratory, survey and quantitative descriptive studies 2. Investigator must demonstrate objectivity and independence from the subject / participant 3. Investigator controls the investigated and directly manipulates variables 4. Investigator takes measurements by way of structured instruments 5. Quantification and statistical analysis techniques 6. Verification of hypotheses and

	<p>researched bring their own subjective experience to the research</p> <p>9. The researcher tries to develop an understanding of the whole and a deep understanding of how each part relates and is connected to the whole.</p>	<p>replicable of observations</p>
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[Source: Adapted from Aliyu, et al., 2015, pp. 4-11].

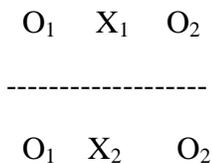
The application of the mixed method in this study was based on face-to-face interviews in order to address the first two research questions, and an experimental approach which involved formulating an a priori research hypothesis to be tested against the collected data

3.3 RESEARCH DESIGNS

According to Sousa, Driessnack and Mendes (2007: 503) “a research design is the framework or guide used for the planning, implementation, and analysis of a study.” The adoption of the mixed research paradigm for this study implied the concomitant adoption of both quantitative and qualitative research designs. In this regard, a case study design was used to find out grade three learners’ understanding of a healthy environment and explore the explanations which lay behind their understanding of a healthy environment. This was done to address the first two research questions. In social science research, the case study represents an important research design with a lot of potential to advance scholarship in various streams of social science research. As Flyvbjerg (2006: 238) points out “the case study is a necessary and sufficient method for certain important research tasks in the social sciences, and it is a method that holds up well when compared to other methods in the gamut of social science research methodology.” Methodologically, Meredith (1998: 442) opines that “a case study typically uses multiple methods and tools for data collection from a number of entities by a direct observer(s) in a single, natural setting that considers temporal and contextual aspects of the contemporary phenomenon under study, but without experimental controls or manipulations.” In a case study, “the methods and tools employed include both quantitative and qualitative approaches as well as obtrusive and unobtrusive methods” (Meredith, 1998: 442). Overall, Meredith (1998: 443) identifies three strengths of the case study, namely that (a) the phenomenon can be studied in its

natural setting and meaningful, relevant theory generated from the understanding gained through observing actual practice; (b) the case method allows the much more meaningful question of why, rather than just what and how, to be answered with a relatively full understanding of the nature and complexity of the complete phenomenon; and (c) the case method lends itself to early, exploratory investigations where the variables are still unknown and the phenomenon not at all understood. Indeed, in this study, there is little known about young children's understanding of the various aspects of the environment, particularly the notion of a healthy environment which is, itself, a term coined only recently. Therefore, in these circumstances, the case study research design was deemed to be appropriate for addressing the first two research questions, which were exploratory in nature.

With respect to the third research question, a quasi-experimental research design was used (Sousa, Driessnack, and Mendes (2007)). The third research question sought to determine whether or not there was a statistically significant difference in learner performance between those taught through a cognitive conflict-based conceptual change model versus those using an instructional approach based on collateral learning theory. Accordingly, the non-equivalent control-group design was adopted:



Probably the most widely used quasi-experimental design in educational research, as well as other sciences, is the non-equivalent control-group design. In this study, the design may be explained as follows:

- (a) Both groups are pre-tested on the dependent variable (O_1);
- (b) The two respective treatment conditions (conceptual change versus collateral learning instructional approaches) are then administered to the two groups (X_1 and X_2 , respectively); and

- (c) Both groups are post-tested on the dependent variable (O_2). Differences in the posttest scores between the two groups would indicate the effectiveness of the treatments.

As a quasi-experimental research design, its distinguishing characteristic is the non-randomisation of subjects with regard to their assignment to experimental groups. Thus, the design uses pre-existing 'intact' groups (classes of learners in this case) for the various treatment conditions. Initially, the research intended to use three experimental groups, as follows:

Group 1: Conceptual-change instructional approach

Group 2: Collateral theory-based instructional approach

Group 3: Normal instruction as usually followed in the school

However, after studying the approaches prescribed in the CAPS document, it became apparent that the recommended instructional approach was based on the conceptual change model. As such, the researcher decided to simply reinforce the approach, rather than take it to be a separate instructional process. Nonetheless, this did not alter the study in any way because the third group was merely going to serve as a comparison group to the two treatment conditions.

3.4 TARGET POPULATION AND RESEARCH SAMPLE

The notions of target population and research sample, together with the associated sampling techniques typically pertain to positivist research where generalisation of findings from the research sample to the target population is a fundamental aspect of such research. In qualitative research, participants usually constitute a naturally occurring entity or are selected / identified purposively. So, in mixed methods research, an uneasy tension obtains whereby because of the demands for representativeness from the quantitative dimension of the research, a target population needs to be defined and sampling techniques described.

Thus, the target population of this study were all Foundation Phase learners in the province of KwaZulu Natal. However, the province is big and it would not have been easy and practical to involve the full breadth and length of the province in constituting the research sample, so the study was confined to the King Cetshwayo district. From this district, four schools were

randomly selected from a list of schools supplied by the district office. The selected schools comprised two from a Township, one peri-rural and the fourth one, urban. The four schools were randomly assigned to the two treatment conditions.

3.5 TREATMENT CONDITIONS

In this section, the researcher describes the theoretical underpinnings supporting the two experimental approaches which were investigated in this study. Undergirding the two treatment conditions was one assumption: that all the participating learners had been exposed to both scientific and traditional worldviews through formal schooling and their interactions with their home communities, respectively.

3.5.1 The Conceptual Change Approach

The contemporary view is that to construct a holistic picture of learning that fosters conceptual change, it is both possible and beneficial to consider a learning situation from more than one theoretical perspective of conceptual change. For example, rather than only considering conceptual changes in knowledge that a student constructs in moving from, say a prescientific notion to a scientific view of a concept, a more complete and informative picture would be painted if these changes were viewed from a multidimensional perspective. This point is explained further by Treagust, and Duit (2009: 91) as follows:

Over the past three decades, researchers of students' conceptions and conceptual change have conceptualised learning as being embedded in various theoretical frames with epistemological, ontological and affective orientations ... [while some have emphasised] the importance of the role of the learner, suggesting that the learner can play an active intentional role in the process of knowledge restructuring

Indeed, the way a student views a concept in terms of its status, its ontological category and the motivational and contextual factors can provide a more holistic picture of conceptual change (Treagust and Duit, 2009: 93). Consequently, a multidimensional framework utilising differing perspectives of conceptual change, including the affective domain, to view a learning situation would have merit. This is what constitutes what is referred to as the integrated approach, which

seeks “to bring together research into conceptual change, learning methods and instructional strategy ... whilst acknowledging the influence, and the domain specificity, of prior knowledge” (Riordan, 2014: 44). In the same vein, Duit and Treagust (2012: 50-51) proffer as follows:

It is essential to embed conceptual change approaches into models of instructional planning that take into account the intimate interaction of all components of instruction, namely, the aims of instruction, the structure of the science content taught in instruction, the instructional methods employed and students’ prior knowledge as well as their interests and self-concepts. In many conceptual change studies, such an inclusive theoretical frame is not explicitly taken into account.

Thus, the teachers who followed the integrated conceptual change approach in this study were given a routine that included (a) clarifying and analysing the subject matter selected for the study (i.e. healthy environment), (b) planning lessons that took into account learners’ interests and self-concepts; many people would agree that an important aim of science instruction is to develop interest in much the same way as to develop students’ pre-instructional conceptions towards the intended science concepts, (c) selecting and implementing instructional approaches that fostered conceptual change by designing learning environments that deliberately supported student learning processes, (d) articulating and clarifying the aim(s) of each lesson, and (e) considering the learners’ prior knowledge in the subject. This conceptual model is illustrated in Figure 3.1.

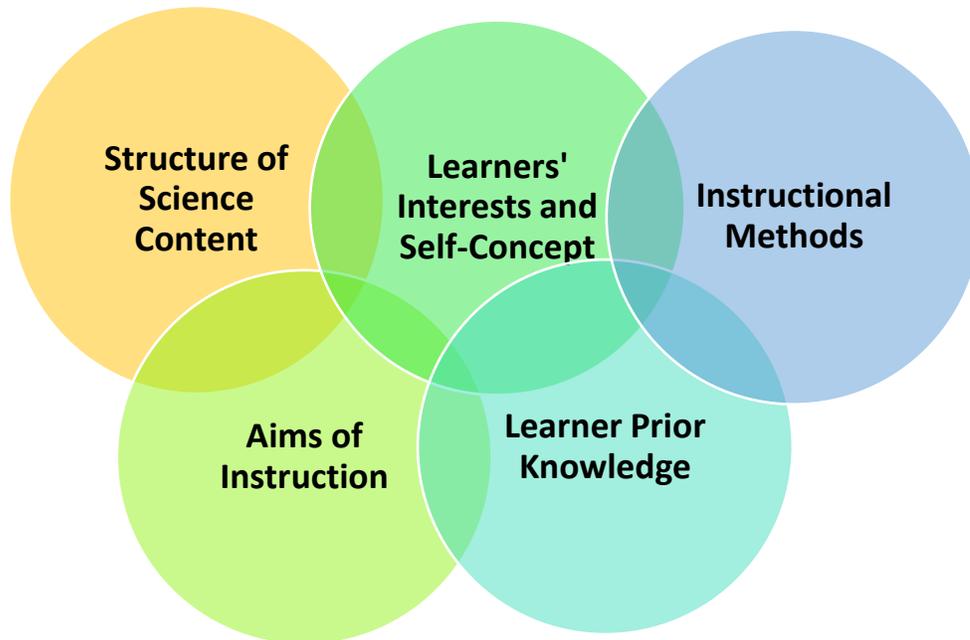


Figure 3.1 The defining elements of the Conceptual Change Approach used in this study [Source: The researcher].

A close scrutiny of the Department of Basic Education CAPS curriculum documents revealed that the recommended instructional approach was fundamentally based on the notion of Conceptual Change. Thus, instead of creating a different treatment condition to represent the Conceptual Change teaching approach, the *status quo* was adopted as representing this approach. However, meetings were held before the teaching of the topics which constituted ‘a healthy environment’ where this approach was explained to the participating teachers so that their actual classroom practice adhered as much as possible to the elements depicted in Figure 3.1. The emphasis in this teaching approach was on applying the ‘conceptual exchange’ model, whereby the teachers’ main concern was to make the learners adopt the explanations which were prescribed in the CAPS documents, with very little effort made to link that ‘knowledge’ with home knowledge. Although this may sound to be an over-simplification of the conceptual change model, the experience of the researcher is that this is how the majority of teachers implement the CAPS curriculum. They pay very little attention, if at all, to the knowledge that learners bring to the classroom. This position is supported by literature that shows that in the majority of cases “actual practice is far from what conceptual change perspectives propose and

that change of this practice continues to be a rather difficult and long-lasting process (Treagust and Duit, 2009: 89).

After teaching has started, the researcher visited each participating teacher twice to satisfy herself that the teaching followed the approach that had been agreed. From what the researcher witnessed, she was satisfied that the teachers implemented what had been agreed to.

3.5.2 The Collateral Learning Approach

For non-Western learners, interaction between two worldviews characterizes much of their school experience, complicating the learning process and potentially resulting in cognitive conflict or as the literature describes it, cognitive dissonance/perturbation. In Africa, schools are the sites where most learners first experience the interaction between African and Western worldviews. It is therefore crucial that teachers working in these contexts (especially Western teachers) be aware of this interaction and understand the way it could complicate the learning process. For this reason, there is an argument for “the integration of indigenous and Western worldviews as the basis for effective science learning in South Africa” (le Grange, 2007: 582). So, conceptual change is then seen as involving the above five dimensions (see Figure 2.2), but in addition, a much more conscious attempt to integrate non-Western epistemologies, ontologies and axiologies. This is where the notion of collateral learning enters the fray (Aikenhead, and Jegede, 1999; Jegede, 1995; 1999). le Grange (2007: 587) advances two reasons why collateral learning must be taken seriously:

Firstly, teachers need to understand the importance of not denigrating or discrediting the indigenous knowledge that learners bring to the classroom because it serves as the framework against which they learn science and also provides the trigger for learning science. Secondly, the four types of collateral learning provide teachers with a framework to mediate and scaffold indigenous learners through different phases of science learning.

While pointing out that for African learners of Western science, duality of thought is a coping mechanism “in a learning environment that is hostile to what indigenous learners bring to the science classroom” (le Grange, 2007: 582), le Grange, justifies the collateral learning approach as follows:

It is widely recognised by sociologists of scientific knowledge and philosophers of science that, even though knowledge systems may differ in their epistemologies, methodologies, logics, cognitive structures or in their socio-economic contexts, a characteristic that they all share is their localness ... Moreover, knowledge is not simply local but located/situated, that is, it has place and creates space. When knowledge is produced it is assembled from heterogeneous components and given coherence through the deployment of social strategies and technical devices. (le Grange, 2007: 586).

In the same spirit, Turnbull (1997: 553) writes that in some cultures and traditions, knowledge is produced “through art, ceremony and ritual” whereas Western science “does it through forming disciplinary societies, building instruments, standardization techniques and writing articles.” Turnbull contends, however, in each case, it is a process of knowledge production “through making connections and negotiating equivalences between the heterogeneous components while simultaneously establishing a social order of trust and authority resulting in a knowledge space” (Turnbull, 1997: 553). The problem is that when science is not taught properly, it tends to generate some negative perceptions for learners. This emanates from the negative modelling of science, by teachers, in ways that do not connect with people’s experiences. Thus, within the context of this study, what is needed is that the cognitive, affective and the learners’ cultural imperatives should be explicitly integrated in a science education that informs environmental education and the human responsibility to care for the environment, leading to informed action. This way, science education will play “an important part in developing understanding of concepts that underpin environmental issues, leading potentially to pro-environmental behaviour” (Littledyke, 2006: 254). To achieve this, teachers are encouraged to incorporate “the development of positive approaches to science and environmental issues through teacher modelling of biophilic behaviour, active learning through constructivist pedagogy, suitable experiences of natural environments and living organisms, and science curricula that emphasise conceptual integration to demonstrate complex environmental effects, including the environmental consequences of human behaviour” (Littledyke, 2006: 254).

Fakudze (2004) conducted a study involving an intervention with respect to a socio-cultural instructional model (SCIM) that integrated indigenous knowledge with school science on the

learners' conceptions of a healthy environment. As described by Fakudze (2004: 271), the SCIM was based on a number the recommendations from different studies – and included, among others, the following:

- a. Generating information about the learners' everyday environment to explain natural phenomena;
- b. Teaching/learning materials that are simple, relevant to the context, and matching the developmental level of the students should;
- c. Holding class discussions that include considerations of different worldview cultural perspectives and other more metaphysical concepts;
- d. Attempt to have adequate time for class discussions in order to accommodate differences in the perceptions of the learners;
- e. Implementing a teaching approach and style that:
 - i. respects the learners by allowing for intellectual independence;
 - ii. encourages active observation, interpretation, and explaining by the learners;
 - iii. exposes learners to a variety of alternative modes of explaining so that the learners can test their views against other views.

This approach was intended to help learners “build bridges between the traditional practices and beliefs and the western science concepts” (Herbert, 2008: 8). As Herbert (2008: 5) explains further, Jegede put forward a model of learning “which provides an alternative to the conceptual (ex)change model as a way of describing the learning outcomes when students, particularly those from non-western societies, are exposed to the culture of science in the formal classroom.” In allowing for bridges to be built across the two knowledge types, that is, western science knowledge (as reflected in the school curriculum) and home knowledge, the researcher chose the route of ‘autonomous’ acculturation. With respect to autonomous acculturation “the students' prior knowledge is honoured and, at the same time, the students can benefit by accessing the cultural capital of western science, as they see fit.” Thus, collateral learning, as actualised in this study favoured “a cross-cultural approach to curriculum design whereby traditional explanations are juxtaposed against western science explanations, with collateral learning as the possible outcome of the learners' experiences” (Herbert, 2008: 7). The approach was based on an effort to obviate the clash that many learners experience between their everyday, traditional cultures

and the “scientific culture, which defines the norms and conventions of scientists’ thinking and behaving” (Zhou, 2012: 118).

For this study, in addition to the five elements that constitute the conceptual change model depicted in Figure 3.1, one more element is added to define the collateral learning approach followed in this study. This is shown in Figure 3.2, where the ‘Indigenous Knowledge Structure and Lived Experience’ of the learners is considered to be the vital missing link for the African and other non-Western learners.

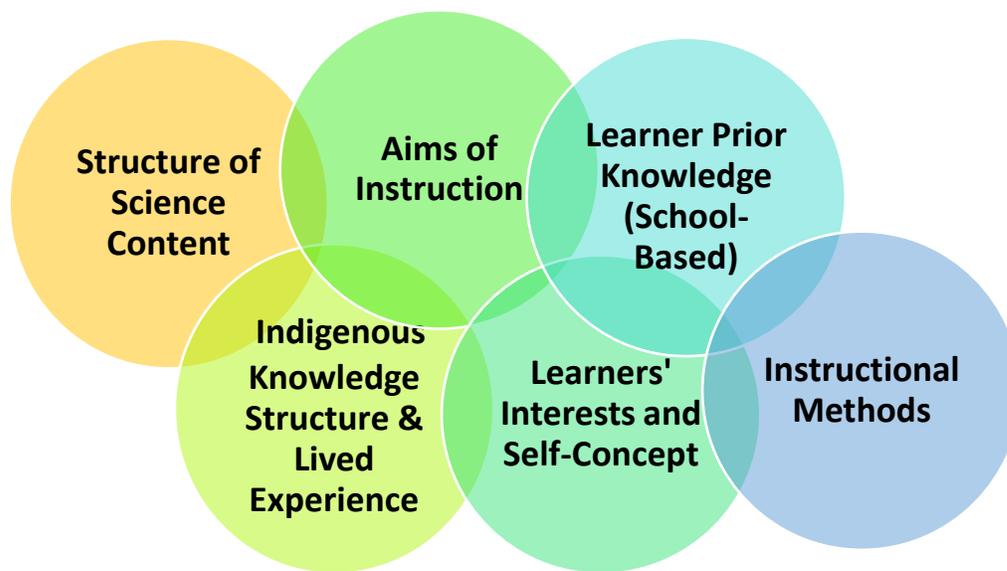


Figure 3.2.: The Main Elements of the Collateral Learning Approach [Source: The researcher]

The current researcher took the view that all learning seeks to foster conceptual change, so the elements that constitute conceptual change are also relevant to collateral learning, but they are not sufficient for non-Western learners who are subjected to a Western-orientated school curriculum, as one finds in South Africa and many other ex-colonial countries.

Although referring specifically to workplace learning, Mallett, Rynnes and Billett (2016: 5-6) present the following key features which are taken to have significantly influenced most current

curricula: (a) consideration of both individual and social dimensions of learning, that is, the notion of relational interdependence between individual and social agency (b) learning is an ongoing temporal process (rather than a product) consistent with Sfard’s (1998) participation metaphor and Hager and Hodkinson’s (2009) notion of ‘becoming’ or emergence (non-linear); (c) individual learning is shaped by social and other contextual factors (i.e., learning is ‘situated’); and (d) problematising current conceptions of learning. The present writer finds these features to be relevant to both workplace and school learning, and to be supportive of the main aim of science teaching, which is “to help all children acquire scientific knowledge, interests, skills, attitudes and ways of thinking without doing violence to their particular cultural beliefs and experiences” (Hodson, 1992: 16).

3.5.3 Topics Covered

The topics covered in this study were drawn from the NCS for Grades R to 3 (DBE, 2011) and are summarised in Table 3.2.

Table 3.2 Topics covered in this study. [Source: DBE, 2011]

<p>3.5.3.1 <i>Healthy Environment</i></p> <ul style="list-style-type: none"> • The importance of a clean environment • Ways in which people pollute the environment • The importance of recycling <p>3.5.3.2 <i>Water</i></p> <ul style="list-style-type: none"> • Uses of water - home and school • Ways water is wasted • Ways of saving water • Safe and unsafe drinking water • Storing clean water 	<p>3.5.3.3 <i>Recycling</i></p> <ul style="list-style-type: none"> • What happens to our waste • Re-using (things that can be used again) • Recycling (used things that can be made into something new) • Reducing (using less) • What cannot be recycled • Recycling at home and at school • Making compost out of things that rot • Re-using water <p>3.5.3.4 <i>Pollution</i></p> <ul style="list-style-type: none"> • What pollution is • Different types of pollution - water, land, air, noise • Effects of pollution on people
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	<ul style="list-style-type: none"> • Effects of pollution on the environment
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3.6 INSTRUMENTATION

Heaton (2005) identifies surveys, focus group interviews, observations and questionnaires as some of the data collecting approaches one can use. In this study, there were several research instruments developed and used. First, were the learning support materials developed to guide the teachers and learners with regard to the target topic (see Annexure K). The next research instrument was the interview schedule which sought to explore the grade three learners’ understanding of a healthy environment and explore the understanding which lay behind their responses concerning a healthy environment (Annexure G1). The fourth instrument was the pre-test which sought to establish the baseline knowledge that the learners had about a healthy environment. The same test also served as a posttest to measure the comparative gains that the learners had made following the two respective interventions (Annexure F1).

3.7 VALIDADTION OF INSTRUMENTS

According to Angen, the etymological root of the term *valid* is the Latin word *valere*, “which means to be well, strong, powerful, or effective and to have worth or value” (Angen, 2000: 392). For positivism, validity is about ensuring that an instrument is a good measure of the true value that is intended to be measured. However, Angen contends that for interpretivist research, validity does not need to be about attaining positivist objective truth, but rather that “it lies more in a subjective, human estimation of what it means to have done something well, having made an effort that is worthy of trust and written up convincingly” (Angen, 2000: 392). As such, what the qualitative researcher needs to do in undertaking valid and scientifically acceptable interpretive research is to do “something meaningful that furthers our understanding and stimulates us to more informed and, hopefully, more humane thought and action” (Angen, 2000: 392). Accordingly, from the meaning of validity as ensuring a valid correspondence to some fixed, external truth through specific criteria, as in positivist research, qualitative researchers concern themselves with establishing a high level of

trustworthiness. In evaluating the trustworthiness of a study, the researcher takes the view that this is an open-ended process which constantly evolves as the research process unfolds – bringing out many possibilities and allowing for changes to be effected as demanded by the exigencies of the conditions on the ground. Thus, once research is seen as an extension of what takes place in society on a daily basis, and not as something that is contrived from non-existent or utopian conditions, then validating research becomes the same problem that people face as they interpret meaning in their daily lives through negotiations, acceptance of ambiguity, and reliance on dialogue (Angen, 2000). Furthermore, much like in the daily interpretations that people make, the conclusions arrived at by qualitative researchers remain open to continued reinterpretation – and are not regarded as proven truths.

Validity refers to the extent to which a concept is accurately measured in relation to what is intended to be measured, “for example, a survey designed to explore depression but which actually measures anxiety would not be considered valid” (Heale and Twycross, 2015: 66). In contrast, *reliability* or *the accuracy of an instrument* refers to “the extent to which a research instrument consistently has the same results if it is used in the same situation on repeated occasions” (Heale and Twycross, 2015: 66). In distinguishing between the two concepts, Heale and Twycross, 2015: 66) give a very good exemplar as follows: “an alarm clock that rings at 7:00 each morning, but is set for 6:30. It is very reliable (it consistently rings the same time each day), but is not valid (it is not ringing at the desired time).”

The most frequently cited forms of validity are *face validity*, where experts are asked their opinion about whether, just by looking at it, the instrument measures the concept intended; *content validity*, whether the instrument adequately covers all the content that it should with respect to the entire domain of the curriculum that is intended to be covered; *construct validity* – whether, in fact, a person who obtains a high score on a survey on mathematical ability is actually very good in mathematics; and *criterion validity* – that is, the extent to which different instruments measure the same variable (Heale and Twycross, 2015: 66).

There are three types of evidence that can be used to demonstrate that a research instrument has construct validity. These are *homogeneity*, when the instrument measures one construct; *convergence*, when the instrument measures concepts similar to that of other instruments which measure the same construct; and *theory evidence*, when participants' 'behaviour' is similar to theoretical propositions of the construct measured in the instrument – such as when participants who demonstrate symptoms of anxiety in their day-to-day lives end up scoring high on an instrument that measures anxiety (Heale and Twycross, 2015: 66).

Criterion validity is also measured in three ways, namely *convergent validity* – to show if an instrument is highly correlated with instruments that measure similar variables; *divergent validity*, when an instrument is poorly correlated with instruments that measure unrelated variables; and *predictive validity*, when an instrument demonstrates a high correlations with future events related to the same variable – for example someone who scores high on a mathematics university admission test goes on to perform very well in mathematics at university.

In this study, face, content and construct validities were used to validate the instructional materials which were developed for the study (Annexures K). First, the materials were developed jointly with the class teachers, and then given to the respective heads of departments to check and sign off. Once this was done, the materials were also checked and validated by the researcher's supervisor and co-supervisor, who were both experts in the field. Similarly, the interview schedule and the pretest / posttest were also developed jointly with the class teachers and validated by the heads of departments and the researcher's supervisor and co-supervisor. Through these processes, the researcher was satisfied that these instruments were appropriately designed and customised for use in the study.

3.8 RELIABILITY

Reliability refers to the consistency of a measure. What this means is that any number of people having the same understanding of a given topic should score approximately the same mark each

time the test is completed (Heale and Twycross, 2015). However, it is not possible to give an exact calculation of reliability. Nonetheless, an estimate of reliability can be achieved through different measures, including the *homogeneity* (internal consistency), the item-to-total correlation, split-half reliability, Kuder-Richardson coefficient and Cronbach's α . In this study, Cronbach's α was used to determine the reliability of the pretest. Concerning the interview schedule,

However, we need to remember that the notion of reliability as meaning repeatability or 'yielding the same result when applied to an object' may not be applicable to human subjects. The reason for this is simply that whereas in positivist research, where the concept of reliability was first defined, researchers deal with inert objects whose characteristics remain the same under defined physical conditions, in social science research one of the complexities of human subjects is that they can react to the same stimulus differently, under similar conditions. They can deliberately change their minds and give a different answer to the same question posed earlier. So, the concept of the reliability of an instrument, such as an interview schedule or questionnaire, assumes a radically different complexion in comparison to its meaning under positivism. This is one of the reasons why some social science researchers (e.g. Morse, et al., 2002; Rolfe, 2006; Johnson and Christensen, 2008; Clarke, 2009; Rubin and Babbie, 2011; Wahyuni, 2012) have called for different ways of characterising and ascertaining the scientific merit of qualitative research, which relies of instruments which cannot yield consistent or repeatable results. Consequently, debate still rages on regarding what mechanisms should be employed to ascertain reliabilities of instruments used to collect qualitative data, such as interview schedules and other ethnographic tools (Golafshani, 2003). As Golafshani (2003: 597) observes, if reliability, validity and triangulation are relevant research concepts in qualitative research, they "have to be redefined in order to reflect the multiple ways of establishing truth."

3.9 DATA COLLECTION PROCESS AND PROCEDURES

The parameters for knowledge-making from the points of view of positivism and interpretivism are distinct in that with positivist scholars believing in the power of replication research, whereas interpretivist researchers cherish studies which uncover “inside perspectives or real meanings of social phenomena from study participants” (Wahyuni, 2012: 71). Axiologically, interpretivist researchers strive to bring out the “insider perspective, which means to study the social reality from the perspective of the people themselves’ in such a way that the experiences and values of both research participants and researchers substantially influence the collection of data and its analysis” (Wahyuni, 2012: 71). Thus, in interpretive research “much of the craft of the inquiry process lies on the shoulders of the person conducting the investigation” and the researcher is responsible for choosing topics that have practical value in the sense of being both relevant and beneficial to those concerned (Angen, 2000: 379). According to Angen, in the process of carrying out the research, a qualitative researcher is never absolved of the ongoing responsibility to decide what is worthy of his/her attention. She further expands on this point as follows:

The complexity of human experience and our shared humanity must feature in our questions, our investigative processes, and, ultimately, our answers. Our own location must be carefully considered and clearly explained. The work we do should be made visible, both in the sense of providing substantive documentation and in the sense that we must publish our efforts or the work amounts to nothing. Our conclusions should always provide new possibilities and remain open to alternate or more expansive interpretations. (Angen, 2000: 392).

Therefore, in qualitative research, the researcher typically collects information through narratives, phenomenologies, ethnographies, grounded theory studies, or case studies, and makes knowledge claims based on constructivist perspectives (Bahari, 2010: 18). In contrast, the quantitative researcher uses experiments, surveys and predetermined measurement instruments to develop knowledge through cause-and-effect thinking, reduction of information to specific variables, hypotheses and questions to test theories (Bahari, 2010: 18). As Golafshani (2003: 598) points out “a quantitative researcher attempts to fragment and delimit phenomena into measurable or common categories that can be applied to all of the subjects or wider and similar situations.” More often than not such a reductionist approach involves the “use of standardised measures so that the varying perspectives and experiences of people can be fit into a limited number of predetermined response categories to which number are assigned” (Patton, 2002: 14).

Creswell (2003) aligns qualitative research with inductive thinking, and quantitative research with deductive thinking, as shown in Figures 3.3 and 3.4 with regard to the data collection processes in these two research paradigms.

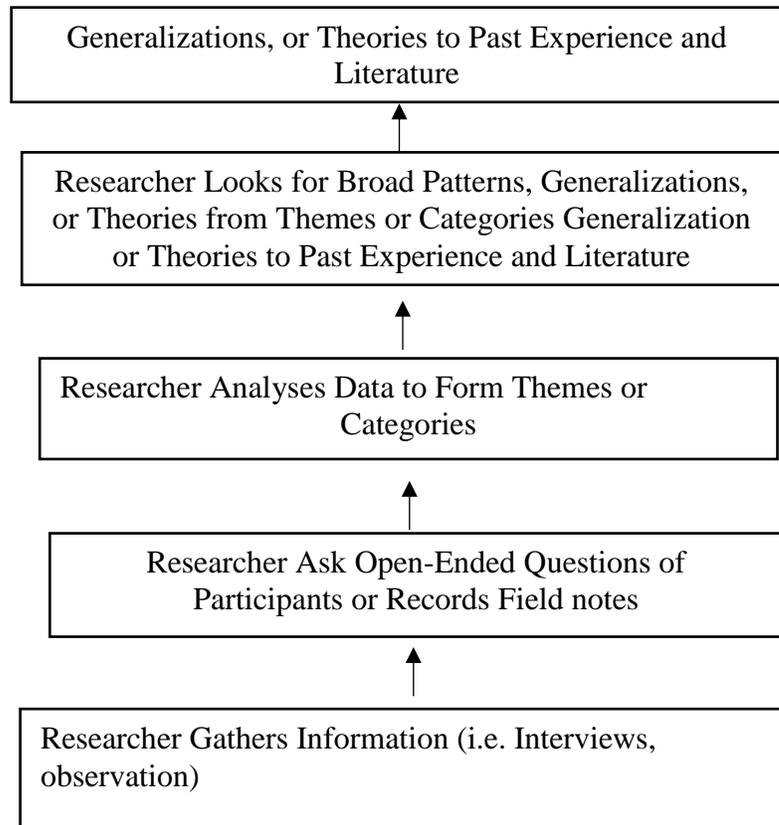


Figure 3.3 The inductive logic [*Source*: Creswell, 2003: 132]

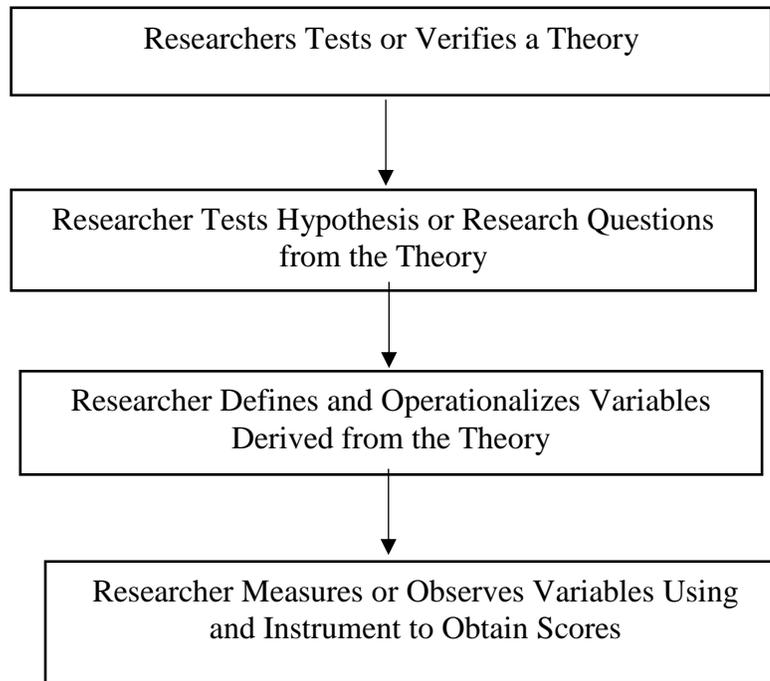


Figure 3.4 The deductive logic [Source: Creswell, 2003: 125]

As a mixed methods research, it means that data collections in this study employed the processes embodied in both Figures 3.3 and 3.4. However, there are some practical challenges when one sets out to collect data from early childhood learners, whose abilities to articulate their thoughts and feelings are still in the early stages of development. This also applies to their levels of confidence. Piko and Bak (2006: 645) make this observation as follows:

Assessing children’s concepts of health presents a special challenge. There is generally concern that children may know more than they are able to say. Therefore, there is a need for a special technique for collecting information from children taking into account their special skills and cognitive abilities. Using children’s drawings, in conjunction with writing (i.e. the draw-and-write technique), can be a powerful method of exploring children’s lay concepts of health.

Thus, in addressing the first two research questions, the researcher used both individual and focus-group interviews having five learners per group. The reasoning behind the use of focus group interviews was to give learners an opportunity to voice their ideas in small groups, supported by the presence of their peers, and in the process tease out the ideas which they may not have found it easy

to express when being interviewed alone – either because of limited vocabulary or low confidence levels. According to Littledyke (2002: 3), group interviews involving four or so children who know each other well, provides “a greater sense of security than individual interviews” and create “the conditions for discussion which can stimulate ideas and extend the conversation through peer interaction.” In this regard, Littledyke (2002: 3) provides a good framework for carrying out interviews by identifying eight ways which an interviewer can use to get as much from an interview as possible:

- a) *Reflecting views* in a way that enables clarification of previous statements. For example, the interviewer may use prompts like, “So do you mean ...?”, or “So what you're saying is ...”. This affords an opportunity to the interviewee to confirm, reject or expand on the point of reflection.
- b) *Facilitating expression of ideas* by giving the interviewee an opportunity to elaborate his/her ideas and/or explain a point in more detail. In this regard, the interviewer may intervene by saying, “Would you tell me more about that?”, or “Could you give an example of what you have just said?”.
- c) *Clarifying an idea/point* to make a statement easier to understand. For instance, the interviewer may say, “Would you please explain that?”, or “Can you say that in another way?”.
- d) *Initiating an idea*. Here the interviewer introduces a new area for consideration to enable the agenda to be efficiently covered. For example they interviewer may ask, “What do you think about ...?”, or “What would you think if I said ...?”.
- e) *Informing the interviewee*. This role may be needed, at times, to explain points which the interviewee may not understand and which were essential to the discussion. For example, explaining, if necessary, what the term environment means in the context of the interview.
- f) *Facilitating the taking of a stance/position* in order to encourage the interviewee to commit to a specific point of view. For instance, the interviewer may ask, “What is your view about ...?”, or “What are your feelings about ...?”.

- g) *Challenging the interviewee* by presenting a different point of view which is not necessarily the view of the interviewer. For instance, the interviewer asks, "What do you think when people say ...?", or "On the other hand, what would you say if ...".
- h) *Confirming/supporting a particular view* in a way that makes the interviewee feel at ease and to encourage the flow of the discussion – which may include confirming responses given by the interviewee, as well as giving remarks which acknowledge common experience. Such responses are important in avoiding distancing in the interview. So, the interviewer may say, "That is a good idea", or "Yes, I've found that also". Non-verbal messages, including non-threatening body posture and confirming gestures and utterances, may also be used – for example nods, 'mm', etc.

In order to maximise on learner participation, both focus group and individually based interviews were conducted. This enabled the researcher to interview several groups of learners, giving her a bigger number of participants than would otherwise have been possible, if only interviews with individual learners were held. Permission was obtained to have all the interviews voice-recorded so that the interviewers (the researcher and her two research assistants) could mainly focus on the conversations with the learners rather than, for instance, on note-taking.

The main purpose of using these techniques was to facilitate free expression and clarification of the ideas which the interviewees may have. Indeed, as Munroe-Chandler (2005: 70) observes, “qualitative research provides insight into another person’s reality.” Thus, the roles of reflecting, facilitating expression of ideas and clarifying the focus of the research helped the interviewer to better understand the questions, whilst the roles of initiating, informing, stance facilitating, and challenging typically focused on introducing new ideas into the discussion. The role of confirming/supporting sought to encourage open expression. Overall, one major advantage of interviews was that they helped to produce data that were based on the respondents’ priorities, opinions and ideas (Maree, 2006). Furthermore, when using interviews respondents have an opportunity to expand and amplify their ideas, explain their thinking and prioritise what they consider to be important.

Data to address the third research question were collected through a written test, administered in the usual way a class test, before and after the instructional intervention. The questions were

made as simple as possible, and were written in the learners' home language (isiZulu), with an option for English with respect to non-Zulu speaking learners. Thus, the learners were allowed to answer either in isiZulu or English.

3.10 DATA ANALYSIS

Both qualitative and quantitative data were collected in this study. Quantitative data were analysed statistically using the Statistical Product and Service Solutions (SPSS). The analysis involved a comparison of the means as a result of the two interventions. To compare the means, the Paired Sample 't'-Test statistic was used. The Paired Samples 't' Test is used to compare two means that are from the same individual, object, or related units. Typically, the two means represent two measurements which were taken at different times, such as in Pretest-Posttest comparisons, which were the ones dealt with in this study. The purpose of the test is to determine whether there is statistical evidence that the mean difference between the paired observations on a particular outcome is significantly different from zero.

Much of the qualitative data analysis was based on content analysis, both from written responses as well as transcribed and translated data arising out of both focus group and individually based interviews. Hsieh and Shannon (2005) define qualitative content analysis as "a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns." Delvin (2006:199) listed the steps to take in qualitative analysis as follows:

- Read through all the written responses
- Create a condensed list of the respondents
- Create a list of categories (not more than six to seven)
- Develop an operational definition for each category.

In this study, the steps recommended by Delvin (2006:199) were followed for easy interpretation of the data and for comparison purposes. The qualitative data collected were coded, rearranged into different categories and recurring themes were identified. The themes that provided explanations related to a healthy environment and the thinking that lay behind the learners'

responses were explored. Finally, for the purpose of substantiating the categories, the learners' responses were quoted, verbatim, where applicable.

Overall, qualitative data analysis arising from the administration of the interview schedule was based on the hermeneutical approach as it “allows one to focus on the text produced according to the question asked as an expression of the respondents' personal experiences and accepted values” (Läänemets, et al, 2012: 29). Furthermore, in hermeneutical analysis, information can be analysed at multiple levels and from different points of view. Hermeneutical analysis is interpretative in nature thus, data analysis is reiterative, ongoing, recursive, and dynamic – evolving from the data rather than based on existing or *a priori* notions (Merriam, 1988; Keeney, Keeney and Chenail, 2015). In this study, the first stage of data analysis involved reading through all the transcripts of the learner responses and creating categories of description to represent emerging themes. This entailed finding patterns from which the themes and conceptual categories can be constructed. In a reiterative process, the recurring themes and conceptual categories were progressively reduced in number by combining conceptually similar ones, resulting in a consolidated, fewer numbers of categories of descriptions.

3.11 ETHICAL CONSIDERATIONS

This study is centred on learner perceptions both as participants in the planned classroom-based learning programmes and as principal sources of data. Thus, the necessary permission from learners and their parents/guardians will have to be secured. In addition, both the University's Ethics Committee and the provincial Education Department will be requested to grant ethical clearance before fieldwork can commence. More specifically, the University's Policy and Procedures on Research Ethics and its Policy Procedures on Managing and Preventing Acts of Plagiarism will be complied with. These were fully discussed with my Promoters to ensure that all ethical issues that may arise from carrying out this research were dealt with appropriately. Furthermore, the various levels of authority affected by this study will be approached for their permission, namely the school principals, district and circuit managers.

Typically, researchers are expected to comply with ethical principles related to honesty, accountability, anonymity, privacy and confidentiality. To Rubin and Babbie (2011: 617)

ensuring anonymity requires making arrangements that make it “impossible for a researcher to link any research data with a given research participant.” They distinguish anonymity from confidentiality, in the sense that with regard to the latter (i.e. confidentiality) “the researcher is able to identify a given person’s responses but essentially promises not to do so publicly.” Wiles, Crow, Heath and Charles (2006: 1) opine that these two concepts are “viewed as akin to the principle of privacy” in-so-far as ethics literature is concerned. Further Wiles, et al (2006: 1) explain that the need for anonymity and confidentiality is integral to “societal beliefs that individuals matter and those individuals have the right for their affairs to be private.” In order to do this, the researcher explained the nature of the study to potential participants and other role players in order to ensure that their participation, or ascent to the study, was out of full understanding of what the study was about. Thus, the following information formed part of the brief to the participants: the purpose of the research; procedures used in research; participants’ right to decline to participate at any stage of the investigation; potential benefits of the research, anonymity and confidentiality. The researcher also ensured that she acknowledged other researchers’ works as required by the etiquette of academic writing.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter presents, interprets and discusses the results to each of the three research questions which guided this study. The presentation of the results is done following the order of the research questions as presented in chapters one and three. However, before this is done, the first part presents the biographical / demographic information of the participants.

4.2 THE DEMOGRAPHIC CHARACTERISTICS OF THE PARTICIPANTS

The two main demographic characteristics of the participants were gender and age.

4.2.1 Gender

The sample consisted of 328 learners of whom 139 (42.38%) were male and 189 (57.62) female. They were divided into two treatment groups – Group 1: Conceptual Change (CC) and Group2: Collateral Learning (CL), consisting of 159 (48.48%) and 169 (51.52%) learners, respectively. Table 4.1 contains a summary of the composition.

Table 4.1 Participants by gender (n=328)

Group	Gender		
	Male	Female	Total
Conceptual Change	57 (17.38)	102 (31.10)	159 (48.48)
Collateral Learning	82 (25.00)	87 (26.52)	169 (51.52)
Total	139 (42.38)	189 (57.62)	328 (100.00)

4.2.2 Age

The age distribution of the participants is presented in Figure 4.1.

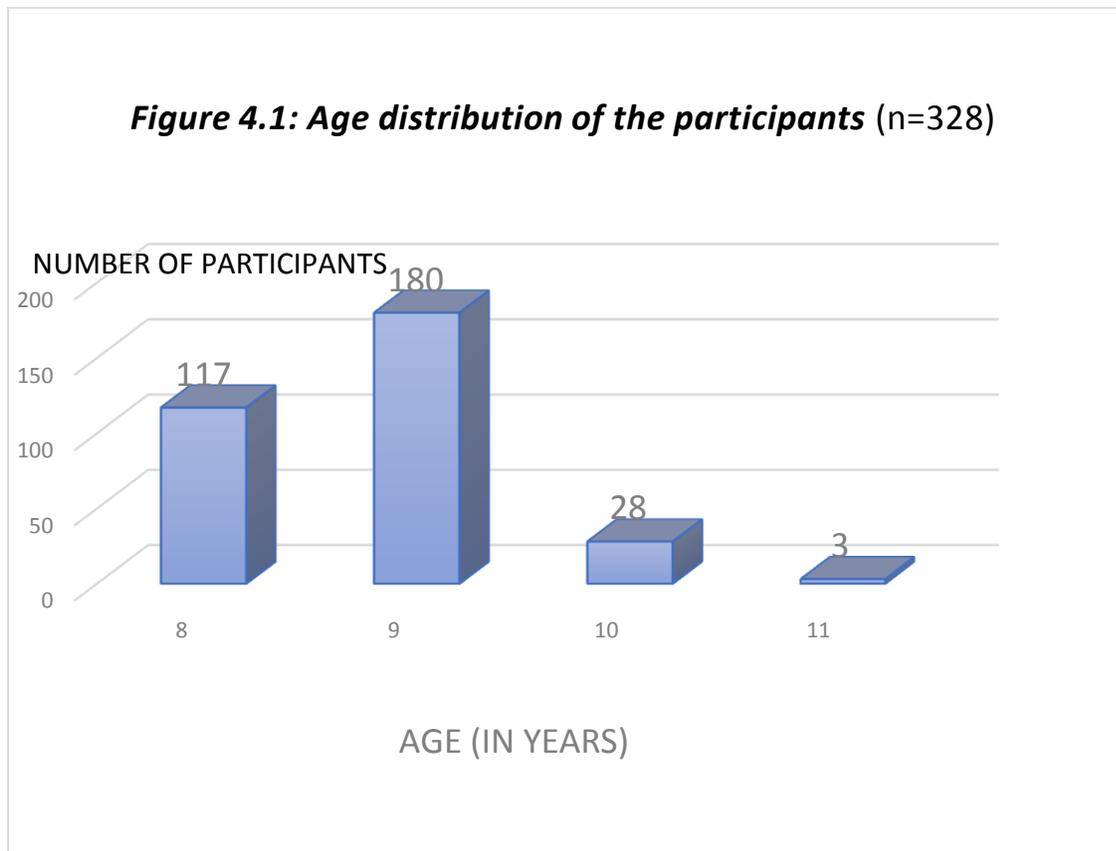


Figure 4.1 shows that although the learners were from the same grade the ages ranged from 8 years old to 11 years old. However, the participants fell predominantly between eight and nine years of age. In South Africa the official age at which learners start grade one is seven, so it is not surprising that these grade three learners were predominantly nine years of age. The policy states that the learner should already have turned seven or will be turning seven during the year he or she starts school in grade one.

4.3 PARTICIPANTS' CONCEPTIONS OF A HEALTHY ENVIRONMENT

The first research question of this study sought to establish the participants' understanding of the concept of a *healthy environment*. In order to achieve this, a test covering basic aspects of a healthy environment, as stipulated in the Foundation Phase (Grades R to three) was administered

to all the learners at the start of the data collection period. The results are presented below according to the various concepts covered in the test.

4.3.1 The Environment

The responses obtained from the majority (100%) of the respondents suggested that they had a good conceptual understanding of the meaning of the term ‘environment’ within the context of the espoused curriculum. This is reflected in the tallied verbatim responses which are presented in Table 4.2.

Table 4.2: Learners’ conceptions of ‘Environment’

Conception	Frequency
1. It is the thing that is around us	246
2. It is where people, crops and animals live	21
3. Soil, tree, and everything we can see	15
4. It is animals, air, people and water	15
5. Everything we use in our lives	10
6. All things that you can touch like water, animals and trees	10
7. Everything we can see and touch	10
8. It is God’s creation	1
Total	328

From Table 4.2, the first seven responses are basically saying the same thing. However, the eighth response brings out a different response category by defining the environment in religious or spiritual terms. Within the context of this study, this answer is very significant because it epitomises the argument about collateral learning, thereby reflecting the difficulty of dealing with home knowledge. Two issues arise out of this response. The first one is a policy issue. In South Africa, teachers are not allowed to interfere with the religious or spiritual faiths and convictions of their learners. This is a matter which belongs to the learner’s home, but what happens in a case like this when the learner brings a home matter to the science classroom?

Collateral learning is about acknowledging and affirming home knowledge, and assisting the learner to border-cross between the authentic knowledge space of the home, and that of the school. So, the policy issue which arises is: “Is the official policy of outlawing religious knowledge from the school curriculum a good policy?”

The second issue relates to the pedagogy itself, and how the teacher should handle home knowledge that is incompatible with the espoused school knowledge. In this regard, the professional and ethical question to ask is: “If the teacher affirms what the learner said about the environment as something that was created by God, would such a teacher have over-stepped his/her mandate?” A related question is: “In the event that the teacher is an atheist (that is, a non-believer) can he /she correct this learner and tell him/her that there is no such thing as God?”

4.3.2 Pollution

Having established that the majority (100%) of the respondents seemed to understand what the environment stood for, the researcher then introduced some terms which related to the notion of a healthy environment. The first one was ‘pollution.’ Tables 4.3A and B express the views of the respondents regarding what they understood by the term ‘pollution.’ Two tables are presented because the analysis revealed two ‘categories of description’ which demonstrated two different ways of conceptualising pollution. Table 4.3A presents responses which centre on pollution as some form or other of ‘contamination’, while Table 4.3B carries notions of pollution which relate to the ‘consequences’ or ‘effects’ of pollution. This latter category of responses demonstrated some understanding of a healthy environment in the sense that the learners alluded to health-related consequences of pollution.

Table 4.3A: Respondents' understanding of pollution

Concept	Frequency
1. When we make our Earth dirty	74
2. Things pollute the air, water and soil	28
3. It is dirt in soil and water	25
4. The thing that makes the earth dirty	25
5. Air and water pollution	22
6. Soil, air, noise, water	21
7. Pollution happens when we litter	20
Total	215

From Table 4.3A, apart from the notion of contamination, there is also reference to the aspects of the environment which may become polluted. The first response which says, 'when we make our Earth dirty' demonstrates an understanding of (a) pollution in relation to Earth as a whole, and (b) that there is 'someone' who is making the earth dirty (a pollution vector). The first response is similar to the fourth and seventh responses. The remaining responses are more specific in terms of what aspect of Planet Earth gets polluted. Overall, there appears to be a good understanding of what pollution is.

Table 4.3B: Respondents’ understanding of pollution in terms of consequences

Conception	Frequency
1. Pollution causes germs	29
2. Pollution disturbs your health	22
3. Water pollution disturbs humans and environment	16
4. Worms come from the land if polluted	16
5. Pollution is sickness and infecting other people with your illness	15
6. Pollution kills crops	15
Total	113

Table 4.3B brings up two interesting points. Apart from defining pollution in terms of its consequences, the learners also bring up the point that pollution ‘kills crops.’ This is a point which goes beyond the other responses in the table which are focused only on human health. The second important observation is that some of the responses in Table 4.3B carry some misconceptions which require a knowledgeable teacher to handle. If not corrected, these misconceptions could be internalised by the learners, and then it becomes quite difficult to address then in the latter years. The response, “Pollution is sickness and infecting other people with your illness” carries two possible misconceptions, namely that ‘pollution is sickness,’ and that pollution means ‘infecting other people with your illness.’ Furthermore, saying that ‘worms come from the land if polluted’ could also be misleading. There are some earth worms which naturally live in the soil, so if one digs them up it does not mean that they resulted from pollution.

4.3.3 Safe Drinking Water

Continuing with the concept of pollution, the learners had the following to say about the concept of ‘safe drinking water’ (see Tables 4.4A and B). As in the case of Tables 4.3A and B, here too, Table 4.4A defines safe drinking water in terms of its characteristic(s), whereas Table 4.4B focuses on its effects or consequences.

Table 4.4A: Learners’ conceptions of safe drinking water

Conception	Frequency
1. When we drink clean water that does not have germs	186
2. Water from taps	32
Total	218

Overall, the answers in Tables 4.4A and B show that the respondents associated safe drinking water with good health, which demonstrated that they had an understanding of a healthy environment with respect to drinking water. The dominant response defines safe drinking water as ‘water that does not have germs.’ Some respondents classified tap water as ‘safe drinking water’. It would be important to correct this misconception as tap water could also contain some ‘germs’ if not purified properly.

Table 4.4B: Learners’ conceptions of safe drinking water, in terms of benefits

Conception	Frequency
1. It makes one healthy	41
2. Makes people to have healthy life and clean	13
3. It gives power	12
4. It cleans all germs in the body	12
5. Your heart will be healthy	10
6. Your body will be clean and healthy	8
7. It is healthy to drink safe water	7
8. It makes me have life on Earth	7
Total	110

The responses in the Table 4.4 defined ‘safe drinking water’ in terms of its effects or consequences. However, like in the case of Table 4.3B, there are some possible misconceptions here as well. Three of the answers in Table 4.4B spring to mind: ‘It gives power,’ ‘It cleans all germs in the body,’ and ‘Your heart will be healthy,’ will need to be handled with deliberate notions of collateral learning in mind. It is possible that these ideas come from common everyday experiences like when someone is thirsty or dehydrated, he or she tends to feel weak, and when the person is eventually given water to drink, he or she may feel much ‘stronger’ – and this is most probably where the answer that drinking clean water ‘gives power’ comes from. However, it is not quite clear where the notions that drinking clean water (a) cleans all germs in the body, and (b) makes one’s heart healthy, come from. These notions require further investigations.

4.3.4 Unsafe Drinking Water

Tables 4.5A and B summarise the learners’ conceptions of what ‘unsafe drinking water’ is.

Table 4.5A: The learners’ conceptions of unsafe drinking water

Conception	Frequency
1. It is dirty water that has germs that will make us sick	162
2. It is to drink water from the dam or where people swim that is not boiled	57
3. It is the water that has too many germs in it	36
4. When we open the whole tap and drink	14
Total	269

In Table 4.5A the learners demonstrated that they had a good understanding of the concept of ‘unsafe drinking water’, and this understanding was complemented by the 59 learners in Table 4.5B who went ahead to describe what would happen if someone drank unsafe drinking water. However, the fourth response category in Table 4.5A could represent a mis- or alternative conception. Alternatively, perhaps these learners are referring to the possibility of choking on a tap which water gushing out at full throttle.

Table 4.5B: Understanding unsafe drinking water in terms of consequences

Conception	Frequency
1. Your system will be dirty	24
2. You won't have good life	20
3. You will have HIV when you drink unsafe water	15
Total	59

In Table 4.5B there were fifteen learners who opined that someone could contract HIV from unsafe drinking water. Teachers need to be aware of this and deal with notion such as this one appropriately in class.

4.3.5 Wasting Water

This was equivalent to the concept of Reduce. Thus, the main focus of this question was on the concept of reducing consumption as one way to conserve water, as a valuable natural resource. The response profile is presented in Tables 4.6A and B.

Table 4.6A: Learners' conceptions of what 'wasting water' means

Conception	Frequency
1. When we leave the tap open	211
2. If you wash your car with the pipe you are wasting water	19
3. Taking a bath too long	17
4. Brushing your teeth while the tap is running is wasting the water	11
5. It means if you have a full glass of water and then you throw it away	3
Total	261

The responses in Table 4.6A show that the majority (80%) of the learners in the research sample had the correct understanding of the notion of ‘wasting water.’ They all described the concept in terms of actions which illustrated the concept. With regard to Table 4.6B, the respondents gave their answers in terms of the effects or consequences of ‘wasting water’.

Table 4.6B: Learners’ conceptions of ‘wasting water’ in terms of consequences

Conception	Frequency
1. Water will finish, and crops and people will die	40
2. If we are wasting water, we will not live healthy life because water is needed in our bodies	14
3. There will be draught in the land	13
Total	67

However, one will have to look more closely at the implied message from the third response category in Table 4.6B, saying that drought is caused by wasting water. Certainly, there are macro climatic reasons which are responsible for climatic changes which manifest in conditions such as drought in certain parts of the world, and not in others.

4.3.6 Using Water Wisely

As in the previous cases, the learner responses are herein also broken down into the two major response types, constituting Tables 4.7A and B. In Table 4.7A the concept of ‘using water wisely’ is defined in terms of actions that demonstrate the concept, while in Table 4.7B the learners’ conceptions of the concept are expressed in terms of consequences of **not** using water wisely.

Table 4.7A: Learners’ conceptions of what it means to use water wisely

Conception	Frequency
1. By closing the tap after using it	99
2. Using water wisely when we drink water from a cup	44
3. Using water wisely is to wash the car by using a bucket	36

4. Using water wisely is not to leave the tap open	30
Total	209

All the four actions cited in Table 4.7A are acceptable ways in which water may be used wisely. So, from here we may say that the research sample had the correct understanding of the notion of using water wisely. Added to the 209 learners in Table 4.7A were the 119 learners who described ‘using water wisely’ in terms of what would happen if water was not used wisely.

Table 4.7B: Learners’ conceptions of ‘using water wisely’ in terms of consequences

Conception	Frequency
1. If we use water wisely it will never finish	57
2. You will live a long life	32
3. Water will not finish and crops won’t die	30
Total	119

Indeed, in the responses in Table 4.7B, the connection of ‘using water wisely’ to the concept of a healthy environment comes alive. By saying that people will ‘live a long life’ and ‘crops won’t die’, the learners are showing the connection between water conservation and a healthy environment.

4.3.7 Recycling

Recycling is one of the important concepts associated with the sustainability of a healthy environment. The learners’ awareness of this concept is presented in Tables 4.8A and B.

Table 4.8A: Learners’ conceptions of what recycling means

Conception	Frequency
1. Recycling is taking something that is old and we make something new	162
2. Using water that has been used	43
Total	205

The responses in Table 4.8A demonstrate that the learners had a good conception of recycling. Indeed, recycling is “minimizing waste generation by recovering and reprocessing usable products that might otherwise become waste” (U.S. Environmental Protection Agency, in Catlin and Wang, 2013:122).

Table 4.8B: Learners’ conceptions of recycling in terms of consequences

Conception	Frequency
1. Recycling makes the area clean	79
2. It keeps the area clean and there is a process of recycling	44
Total	123

The responses in Table 4.8B affirm the respondents’ understanding of recycling.

4.3.8 Re-Using Scarce Natural Resources

Re-using is one of the strategies used to reduce the human urge to acquire more and more new stuff. As Abdul-Rahman (2014: 3) points out, “the process of reusing starts with the assumption that the used materials that flow through our lives can be a resource rather than refuse.” This concept is part of the Foundation Phase curriculum in South Africa. The respondents’ understanding of this concept is reflected in Tables 4.9A and B.

Table 4.9A: Learners’ conceptions of the meaning of ‘reusing scarce natural resources’

Conception	Frequency
1. Re-using is to use a thing again	125
2. Re-using is to use plastics many times	54
3. Re-using tins, bottles and cans	21
Total	200

From the responses in Table 4.9A, the researcher surmises that the learners were *au fait* with this concept. This was gratifying.

Table 4.9B: Learners’ conceptions of ‘re-using scarce natural resources’ in terms of consequences

Conception	Frequency
1. To save nature	70
2. If you use the sun for electricity air pollution would be less	58
Total	128

The learner responses in Table 4.9B affirm those in Table 4.9A in demonstrating the learners’ understanding of the importance of re-using scarce natural resources. It is pleasing to see that learners in the Foundation Phase can demonstrate this level of understanding of this concept. Hopefully, the school system can build on this foundation and consolidate what the learners already know in subsequent school grades.

4.3.8 Reducing (in the context of conserving scarce natural resources)

This item is related to re-using in the sense that when one delays discarding old items and uses them over an extended period of time, this limits the frequency of buying similar items. As Abdul-Rahman (2014: 2) points out, “reducing the amount you buy is the most significant of all the options to manage waste ... If each household reduces its waste, the problem will be reduced.” In this regard, the learners in this study reacted to this item as follows:

Table 4.10: Learners’ conceptions of what ‘reducing’ means

Conception	Frequency
1. Prune trees don’t cut them	98
2. People must stop killing rhinos	67
3. Reducing the use of cans, plastic bottles	44
4. Reducing is to use small amounts like water and plastics	42
5. Reducing the amount of water we use by using water in small quantities	40

6. Reducing is closing the water slowly	37
Total	328

From a definitional point of view, response items 4 and 5 in Table 4.10 are the ones which typify what the concept of reducing stands for. One way to understand this concept is to see it as meaning that people must minimise the amount of waste that they create so that, in the end, they have less rubbish to get rid of. As for the other responses in Table 4.10, each one of them has its own merit and significance. Pruning trees, instead of cutting them down is about conserving out natural resources. In the minds of these learners, they are probably referring to ‘reducing’ the devastation of our trees/forests. In a similar way, by saying ‘stop killing rhino’ these learners are probably saying to the world, “Reduce the rate at which you are killing the rhino.” Accordingly, teachers need to pay attention to these ‘misunderstandings’, to ensure that the learners do not bank these unintended misinterpretations of concepts. Response item number 6, needed further probing.

4.3.9 Different Types of Pollution Known to the Respondents

This question simply intended to reveal what the learners knew about the various types of pollution as covered in their curriculum. In a spiral way, various aspects of the healthy environment are taught between grade R and grade 3. So, in a way, by conducting this study towards the end of grade 3 (which marks the end of the Foundation Phase), the learners had covered most of the related topics. It may, therefore, not have been surprising that most of the learners were able to mention the various types of pollution. Table 4.11 presents the responses of the learners.

Table 4.11: Different types of pollution known to the respondents

Conception	Frequency
1. Different types of pollution are soil pollution, water pollution, air pollution and noise pollution	97
2. Water and air pollution	85
3. Water, air and land pollution	54

4. Water, soil pollution, noise pollution	42
5. I know the soil pollution and noise pollution	28
6. The factories are pollution the air	22
Total	328

The response profile in Table 4.11 suggests that most respondents were familiar with the various types of pollution.

4.3.10 How Pollution Affects People

The respondents' conceptions of how pollution affects people are presented in Table 4.12.

Table 4.12: Ways in which pollution affects people

Conception	Frequency
1. Pollution makes people sick or ill	80
2. Pollution causes people pain, and makes them sick and die	65
3. People cannot breathe properly because of inhaling bad gases and air	41
4. People get different illnesses	40
5. You can have a wound in your skin and you can have cancer	35
6. Pollution can make people die and old granny can lose her hearing	30
7. Pollution makes you not to see	20
8. When people breathe smoke it affects their lungs	17
Total	328

The responses indicate that the learners were quite aware of different adverse effects of the various types of pollution. Some responses were quite general, such as 'make people sick or die,' 'not to see,' or 'people get different illnesses.' Some are more specific to the pollution vector, such as 'when people breathe smoke it affects their lungs.' The response that pollution could cause 'old granny to lose her hearing' could suggest that these learners hold the belief that

noise pollution, for instance, affects only old people’s hearing, and not young ones – which would be a misconception. Overall, however, it could be said that these learners understood that pollution was an enemy of the people’s health.

4.3.11 How Pollution Affects the Environment

Further to the effects of pollution on people, the respondents were similarly asked to say how they thought pollution affected the environment. Their responses are captured in Table 4.13.

Table 4.13: Ways in which pollution affects the environment

Conception	Frequency
1. The animals, plants and trees can die	66
2. It gets dirty	66
3. Environment can no longer clean itself	58
4. The air affects the environment with dirt and smoke	53
5. It can make our environment ugly	50
6. Crops won’t grow	35
Total	328

The responses in Table 4.13 indicate that the learners were, again, quite familiar with some of the adverse ways in which pollution affected the environment, ranging from making it dirty or ugly, to affecting plant life adversely.

4.4 EXPLANATIONS UNDERGIRDING THE LEARNERS’ CONCEPTIONS OF A HEALTHY ENVIRONMENT

Following the administration of the pre-test, interviews were conducted with samples of the learners according to how they performed in the pre-test in order to explore the thinking that lay behind their understanding of a healthy environment. The interviews were based on pictures which showed various aspects of the environment, covering the concepts of recycling, re-using,

using less and pollution (water, land / soil, air and noise). All these concepts were prescribed in the Foundation Phase curriculum.

The interviews were held in English for learners who were taught in English, and were comfortable to express themselves in English. Those who preferred to be interviewed in isZulu were interviewed in isZulu. Two types of interviews were conducted: individual (six per school, giving a total of twenty-four), and focus group interviews comprising six learners per group – two per school, giving a total of forty- eight participants. Since each picture focused on one environmental concept at a time, the data analysis, presentation and interpretation below follow the order in which the interviews were conducted.

Both the individual and focus group interviews were based on the same picture, and were conducted in the same order. For each picture, the entry question was to ask the respondents what they saw in the picture and what they thought was happening in the picture. Thereafter, follow-up questions were built on the learners' responses, and attempted to probe deeper in order to get to the reasoning behind the learner's answers – whether correct or not. Since the responses from both types of interviews were meant to answer the same question, these responses are all integrated in the way the results are presented – that is, the responses about each picture from the one-on-one interviews and from the focus group interviews are presented together.

4.4.1 Recycling

To find out whether or not the participants understood the concept of recycling, they were presented with Picture 1.

Picture 1



Overall, the result indicated that the learners did not have the concept of recycling. Most were able to say what they saw in the picture, that is, “a man making shoes from tyres,” but they were not able to explain what they observed in terms of recycling, and the benefits of recycling. To illustrate this point, three responses are given below to show how the learners explained what they observed about Picture 1:

- *In this picture I see a boy fixing tyres and another one is sitting next to him and is kneeling and he is looking at what the other man is doing. I think he is learning how to make shoes using tyres. (F1, 8 – Female learner 1, 8 years old).*
- *Boys talking or children making shoes using car tyres. They are cutting tyres and making nails or shoe glue. There are many tyres on the ground; they are cutting them making shoes. (M3, 9 – Male learner 3, 9 years old).*
- *I see a child and man opening shoes out and a child is kneeling fixing black tyres and these tyres are fixed by this small child. There are children in the sand holding cans. (M4, 9 – Male learner 4, 9 years old).*

The following interview except illustrates the effort that was made to establish whether or not the learners understood the concept of recycling. This was how the interviewer attempted to probe a little deeper, in order to establish whether or not the learners understood the concept of recycling.

Focus Group Interview 3

Interviewer: *What can you see in the picture?*

Learner E: *I see people making shoes using tyres*

Learner B: *I see shoes placed nicely on the ground, one after another*

Learner A: *I see children making shoes.*

Interviewer: *Do the tyres in the picture look new or old?*

All Learners: *They look old.*

Interviewer: *Why do you think they are using old tyres to make shoes?*

Learner A: *To help people without shoes*

Interviewer: *Do you think what they are doing is nice or not?*

All Learners: *It is nice*

Interviewer: *Why do you say it is nice?*

Learner D: *It helps people to wear shoes*

Learner E: *It helps barefooted people to have shoes*

Learner C: *So that we are not hurt by broken bottles and stones.*

This interview was typical of the interviews regarding Picture 1. Apart from the social benefits of wearing shoes, the interviews did not yield a response which showed that the learners associated the notion or concept of recycling with what the man in the picture was doing.

4.4.2 Water Pollution

Picture 2 concerned water pollution, and its effects on the environment.



Presented below are the responses obtained from individual learners concerning the above picture:

- *A person is fishing dead fishes because of dirty water, people eat them and become sick. (F3, 8)*
- *I see a person catching dead fishes because of dirty water. (F6, 9)*
- *A white man is surrounded by dead fishes in the water, fishes are in the bucket and floating in the water. (M2, 9)*
- *I see a person standing where there is a lot of fishes all over and is taking them, putting them in a basin and he is filling the basin. (M8, 8)*
- *There is a person and dead fish because the water is dirty. It is not healthy. (M6, 9)*
- *A person is fishing holding a net for catching fish so that he can take them to eat even when the water is dirty. The fishes are just floating and whoever wants can go there to collect them. (F7, 10)*

In these responses, there is an inter-play between dirty water and the dead fish. One can say that the learners are attributing the dead fish to have resulted from the water being dirty.

Focus Group Interview 6

Interviewer: What do you see in the picture?

Learner B: I can see a person holding a fish

Learner C: I see many fishes in the sea

Learner E: I can see dead fish in the sea

Interviewer: Are these fish dead or alive?

Learner D: They are alive

Learner A: No, the fish are dead because water is dirty

Interviewer: Are you saying dirty water can kill fish?

Learner A: Fish needs clean water.

Interviewer: Do you know what could have made the water dirty?

Learner B: People are throwing lots of dirty things in the water

Learner C: There are chemicals that come from the factory and pollute the water

Interviewer: What made the fish to die?

Learner: Because the water is dirty and fish live in clean water

Interviewer: Learner E what do you say?

Learner E: People pollute water and animals can't live in dirty water

Interviewer: Is that true?

All learners: Yes

Interviewer: When you look at the water is it dirty or clean

Learner B: The water is dirty

Interviewer: Do you think it is good or bad to have dirty water?

All Learners: Not good

Interviewer: Why do you all say that it is bad?

Learner E: Because the fish also like to breathe clean water.

The individual interviewed also generated similar responses which showed that the learners were generally familiar with water pollution and its adverse effects on fish. However as pointed out already, some misconceptions also surfaced. In the last line, for instance, the phrase “breathe clean water” could be misleading in the sense that learners must know that fish also breathe in air, *albeit* extracted from the water.

4.4.3 Land / Soil Pollution

The third picture related to land or soil pollution:



Below are some of the responses obtained from individual learners concerning Picture 3:

- *Orphaned children are dirty and they are picking up things in the pit or eating in the bins.*
- *Children are busy, one is sitting on the bicycle, others sitting in tyres full of papers in the ground. Children should not throw papers around or in the water because it will be polluted and have chemical.*
- *Children are playing here, although it is dirty burning papers. Full of bottles and papers and there are buckets where they are sitting and they are going to say it is not a safe place because there are germs.*

Overall, there was a general view that this was a dumping site which demonstrated land or soil pollution. The learners' allusion to 'burning' could also suggest air pollution. Below is a sample individual interview to illustrate how the learners viewed Picture 3.

Individual Interview 9

Interviewer: What can you see in this picture?

Learner Number 12 (F14, 9): *I can see a dumping place and the children playing there.*

Interviewer: *Do you think it is a good idea to have a dumping place like that?*

Learner Number 12: *It is bad*

Interviewer: *Why do you say so?*

Learner Number 12: *Because it pollutes the land*

Interviewer: *How is land polluted according to what you see?*

Learner Number 12: *The land is polluted by papers, plastics, cans, bottles and broken buckets.*

Interviewer: *How could this be prevented?*

Learner Number 12: *By not throwing rubbish, papers and not burning the rubbish.*

Interviewer: *What happens when the rubbish is burned?*

Learner Number 12: *We cannot breathe properly.*

Interviewer: *What should we do to avoid this?*

Learner Number 12: *We must not play where there is smoke or at a dumping site.*

Interviewer: *So, it is not safe for the children to play there?*

Learner Number 12: *No, it is not.*

Interviewer: *Why?*

Learner Number 12: *The place is full of broken bottles and old cans. Broken bottles will hurt them. They can also get burned.*

Interviewer: *Do you think the environment is healthy or not?*

Learner Number 12: *It is not healthy, because there is littering. I see children picking papers others playing; I can see a child playing with a bicycle near the water;*

I see something like paper, baby sitting in the soil and some people are picking up some papers; I can see dirt, smoke and the children are fetching water. It is not a healthy environment.

Interviewer: *What kind of smoke is in the picture?*

Learner Number 12: *Fire smoke.*

Interviewer: *If it is fire smoke, do you think it is a good smoke?*

Learner Number 12: *No, it is a bad smoke because it pollutes the air.*

Interviewer: *Do you think it is dangerous for the children who are playing there?*

Learner Number 12: *Yes, it is because they can get hurt.*

Interviewer: *Why is it not a good thing to be exposed to smoke?*

Learner Number 12: *It hurts eyes and makes you cough.*

It is clear from the responses given by this learner that she was aware about the land pollution and its adverse effects. Overall, although the other interviews (both individual and focus groups) also demonstrated that, for their age, the learners had an adequate understanding of land or soil pollution and its bad effects on people.

4.4.4 Unsafe Drinking Water

Owing to the dangers and pervasiveness of unsafe drinking water, the learners were presented with Picture 4, showing two glasses of clean and dirty water, and were asked to indicate which glass of water contained water which was unsafe to drink. In Picture 1, the focus was on the environmental pollution away from home, whereas in Picture 4, the focus was on the dangers pertaining to the water people drink in their homes.



The following focus group interview is presented to illustrate the general view of the participants concerning Picture 4, which focused on identifying safe and unsafe drinking water.

Focus Group Interview 2

Interviewer: What do you see in this picture?

Learner D: I can see two glasses, one with dirty water and one with clean water.

Interviewer: What will happen if you drink the clean water?

Learner E: You become healthy.

Learner D: You have enough blood

Interviewer: What happens when you drink the dirty water?

Learner B: You become sick.

Learner C: You are attacked by TB.

Learner A: You cough.

Learner E: You can die because you don't know what is in the water.

Interviewer: *If you look at this glass [pointing to the glass with dirty water] what do you think is inside?*

Learner C: *Sand*

Learner B: *dirt*

Learner A: *Mud*

Learner E: *Sugar*

Interviewer: *Learner E, why do you say there is sugar inside?*

Learner E: *Because it looks as if it has sugar.*

Interviewer: Would any one of you here like to drink this water [pointing to the glass with dirty water]

All Learners: No.

Interviewer: Why not?

Learner B: It will make you sick.

Learner A: Perhaps there are germs inside.

Learner C: The water is dirty.

Interviewer: Learner E, what do you say?

Learner E: It is not good to drink dirty water. It can make you sick.

From the above sample interview, it may be said that the learners were able to distinguish between water that was safe to drink and water that was unsafe to drink. However, a couple of misconceptions also surfaced from the learner's responses. These include (a) the view that one can catch TB from drinking dirty water, and (b) that drinking clean water results in someone having enough blood. A skilful teacher would need to address these issues before they become deeply engrained in the minds of the learners.

4.4.5 Air Pollution

Picture 5 was about air pollution.



The following sample statements represent some of the learners' views about Picture 5:

- *Black smoke coming from buildings and you are not allowed to sit in the black smoke like that because you are going to suffer from chest. (F2, 9).*
- *I see smoke from the mines. This smoke causes diseases and it is caused by mine workers. (M11, 10).*
- *This is about dirty water polluted by smoke from where we are burning and also coming from the factories. (F17, 9).*
- *Smoke coming from the mine goes to the heaven, moving and changing the clouds to look like smoke from iron which pollutes air and people get sick. (M19, 9).*

There was a general acknowledgement that smoke was being produced from the factory, and that this posed some danger to people's health.

Individual Interview 7

Interviewer: What can you see in this picture?

Learner: I can see all the factories with all the chimneys and the air is coming out. There is smoke like carbon dioxide.

Interviewer: Where does the smoke go?

Learner: The smoke is polluting the air.

Interviewer: How is it polluting the air?

Learner: We are going to inhale polluted air and it will make us ill.

Interviewer: How can we prevent air pollution?

Learner: We should not burn trees and grass because the smoke goes in the air.

Interviewer: How does air pollution affect the environment?

Learner: It will affect us, the plants, animals we may die.

Interviewer: How does air pollution affect the things you mentioned?

Learner Number 1: We will get sick and the plants and animals will also die.

The other individual interviews as well as focus group interviews indicated that most learners were familiar with what air pollution was, and how it affected both the environment and living things in that environment.

4.4.6 Re-Using

Collateral learning is about authentic learning which, in turn, refers to ‘learning-in-context’. It is possible that a child who comes from a European environment would find it difficult to understand what is going on in Picture 6. However, for most children in rural Africa, using plastic containers to fetch water from rivers, wells and streams is a common practice. The

question for the study was whether or not the learners associated this with the environmental concept of re-using; as a practice which was good for the planet because it limited throwing away used items – which would result in dirtying the environment and buying more stuff (in this case, plastic containers) to replace the ones which have been thrown away.



Some of the responses obtained from the interviews with learners were:

- *I see people and children collecting dirty water while others are urinating in the water. (M5, 10)*
- *The picture is about poor people collecting dirty water and drinking it, and they are using dirty containers. (F4, 9)*
- *People are experiencing problems collecting water; some collect with a boat, you are not allowed to drink dirty water because you are going to suffer from cholera if you do you will die. (M3, 9)*
- *Importance of environment people should pick up papers and rubbish to keep the ground or place clean.*

There were probably too many things one could observe from Picture 6. The primary focus was on the containers which were being re-used, however, the question of dirty water appeared to be the popular focus among the participants. Almost all the interviewees said something about the dirty water. Even when they said something about the containers, it was more in the context of 'dirty containers'. The following interview sample epitomises this point:

Individual Interview 5

Interviewer: What can you see in the picture?

Learner (F14, 9): I can see people fetching water which seems like not safe and they are using dirty containers.

Interviewer: Why do you think the water is unsafe to drink?

Learner: Because it is not clean, it has germs and people wash their bodies there.

Interviewer: Why do you say that it is not clean?

Learner: Because people throw in dirty things and people die in there and wash their bodies in there.

Learner: I can see some grass and a boat, bicycle, containers, water.

Interviewer: What are they using to fetch water?

Learner: They are using bottles and some old containers.

Interviewer: What do you think these containers were originally used for?

Learner: They put petrol, cooking oil, and sometimes juice.

Interviewer: Do you think it is a good thing to use them to fetch water?

Learner: Yes, because they can be re-used.

In the end, the concept came out. It is possible that because of the earlier pictures which focused the minds on these learners on water pollution, they also took this picture to be about water

pollution. In almost all cases, the learners made the point that these containers could have been used for something else, and could now be used to fetch water – or for any other purpose. However, what was missing from the interviews was to establish whether or not the learners connected the re-using of the containers to the sustainability of a healthy environment.

4.4.7 Noise Pollution

Many people are disturbed by loud noises, but perhaps not as many see it as a form of pollution. In this study, Picture 7 was used to find out from the learners what they thought about the picture.



In epitomising the responses obtained from the learners two interview transcripts are presented as follows:

Individual Interview 8 (Learner F15, 9)

Interviewer: What can you see in the picture?

Learner: I can see loud speakers and a man who is blocking his ears standing next to the speakers.

Interviewer: What do you think the man is doing?

Learner: He is screaming and blocking his ears.

Interviewer: Why is he doing that?

Learner: Because loud noise hurts his ears and he can't hear properly.

Interviewer: What else can you say about Picture 7?

Learner: The man does not want noise.

Interviewer: Why is that so?

Learner: Because it is bad.

Interviewer: Why is it bad?

Learner: Because the noise can destroy your ear drum.

Interviewer: What could be the effect of that?

Learner: It can burst the ear and then you cannot hear properly. I can see pollution.

Interviewer: What kind of pollution?

Learner: It is noise pollution.

Interviewer: Are there other pollutions which you know of?

Learner: Yes

Interviewer: Can you name them?

Learner: Eeuh, one is water pollution, soil pollution, air and noise.

Interviewer: Are these pollutions good or bad?

Learner: They are bad to our health.

It is clear that this learner has an understanding of what noise pollution is, and that there are some adverse effects associated with it. Similar sentiments and level of understanding were expressed in the focus group interviews, as demonstrated below:

Focus Group Interview 1

Interviewer: What do you see in this picture?

Learners D and B: I can see a man blocking his ears because of the noise.

Interviewer: Is noise good or bad?

Learner A: It is bad.

Interviewer: Why do you say it is bad?

Learners B and D: Because it affects people's ears.

Learner A: Because ears will be blocked.

Learner C: Because it can affect your ears until you don't hear.

Learner A: It is bad if you have a headache, you don't need noise.

Interviewer: How can we prevent this noise?

Learner A: By putting a board that warns people from making noise.

From these interviews, it is evident that the learners understood the concept of noise pollution, and its consequences on human health.

4.4.8 Re-Using

Re-using has found expression in many different ways, depending on people's creativity and ingenuity. For this reason, a second picture was used to see if it could trigger an understanding of

the concept of re-using, and how it benefits the environment. This question was similar to Picture 6. The slight difference was that Picture 8 also had some elements of recycling in the sense that some aesthetic value had been added to the tyres, which were made attractive by being painted in different colours. Having more than one question testing the same concept is also good for instrument reliability. If learner responses between the two questions focusing on the same concept have a high level of consistency, then instrument reliability is said to be good. This is quite important, especially in qualitative research.

The basic conceptual difference between re-using and recycling is that in the former (re-using) an item is used in the same condition as it was used in the original context. In recycling, waste material is processed to produce something else (new) which is useful. Picture 8 was put to the learners:



Picture 8

The learners' responses are highlighted in the following sample individual interview, followed by a sample focus group interview:

Individual Interview 8 (M16, 9)

Interviewer: What can you see in the picture?

Learner: I can see the painted tyres and the soil and the different flowers

Interviewer: What else can you see?

Learner: I can see tyres and some flowers which is a good environment

Interviewer: What can you say about the tyres?

Learner: I can see they are re-using the tyres

Interviewer: Were these tyres meant for flowers or not?

Learner: No, they have been recycled and have been painted to all good plants

Interviewer: Why are they painted in different colours?

Learner: So that they can know which type of flower to be put in a green tyre or pink tyre and it looks nice.

Interviewer: Do you think it is a good idea to paint them in different colours?

Learner: Yes, it is good. Because they make flowers look good.

Interviewer: What can we do to keep them healthy?

Learner: The flowers should be watered often

Focus Group Interview 5

Interviewer: Looking at this picture, what do you think is happening?

Learners E, A and B: I can see painted tyres with some flowers.

Learner C: I see flowers blossoming.

Learner D: I see tyres in different colours.

Interviewer: What purpose are the tyres serving?

Learner E: To grow plants and flowers.

Learner C: It moves cars.

Learner D: It holds flowers from falling.

Interviewer: What is good or bad about this picture?

Learner C: It helps people to have good plans.

Interviewer: What is good about tyres?

Learner A: Children play with them making cars and my mother uses them for planting vegetables.

Interviewer: Does that mean you can use tyres for different things?

Learner A: Yes, but when they are new they are only used on cars. When they are thrown away, then the children can play with them.

Interviewer: Is it good or bad when people use old tyres which have been thrown away?

Learner C: It is good because if they are not picked up and used again, they will dirty the environment.

Learner B: Sometimes, they take old tyres away to make new tyres. This helps clean up the environment.

This interview brought up some interesting observations, bringing the two concepts of re-using and recycling to explain what Picture 8 was about. However, because other interviews did not explicitly establish the benefits of re-using to the environment, it may be said that this was partially achieved on the part of most learners.

4.5 COGNITIVE CONFLICT-BASED CONCEPTUAL CHANGE APPROACH VERSUS COLLATERAL LEARNING APPROACH

The third and final research question of this study sought to establish whether or not there would be a statistically significant difference in learner achievement between those taught through a cognitive conflict-based conceptual change approach versus those taught through an instructional approach based on Collateral Learning Theory. To do this, out of the four schools which had been selected to participate in this study, two schools were randomly assigned to the Conceptual Change (CC) instructional approach, while the other two were assigned to the Collateral Learning (CL) approach. There were two main distinguishing features of these approaches. As explained in chapter three, the researcher found that the instructional approach prescribed in the CAPS document was very closely aligned with conceptual change based on the cognitive conflict model. So, the two schools which were assigned to this treatment condition were allowed to teach as prescribed by the CAPS documents, and the researcher frequently visited these classrooms to monitor and verify that this approach was followed.

On the other hand, the collateral approach needed to be defined and operationalised for the other teachers. Thus, there were two elements which were built into the lessons of the teachers following the CL approach. The first was that each lesson would introduce the topic and then spend about ten minutes, or so, either in plenary or in small groups for the learners to articulate what they understood about the topic in relation to their home conditions and environment. This was not the same thing as bringing home knowledge to the classroom, which collateral learning advocates, but it was an attempt to remove (or minimise) the foreignness of science concepts and lessons often experienced by African learners. It was a way of assisting the learners to border-cross between the home and classroom environments. Secondly, the teachers were assisted with a document, prepared by the researcher, which had home-based examples which she felt could bridge both the conceptual and socio-cultural gaps for the learners.

With regard to the data collection process, learners were given a pre-test and a post-test to assess the effects of the two treatment conditions. For the purposes of the analysis Age was treated as a

covariate (8.75 years) and, hence, adjusted averages were used. Analysis of the results was done using a Repeated Measures Two-Way Analysis of Variance (ANOVA) in SPSS v24. The charts were constructed using MS Excel from Office 2013.

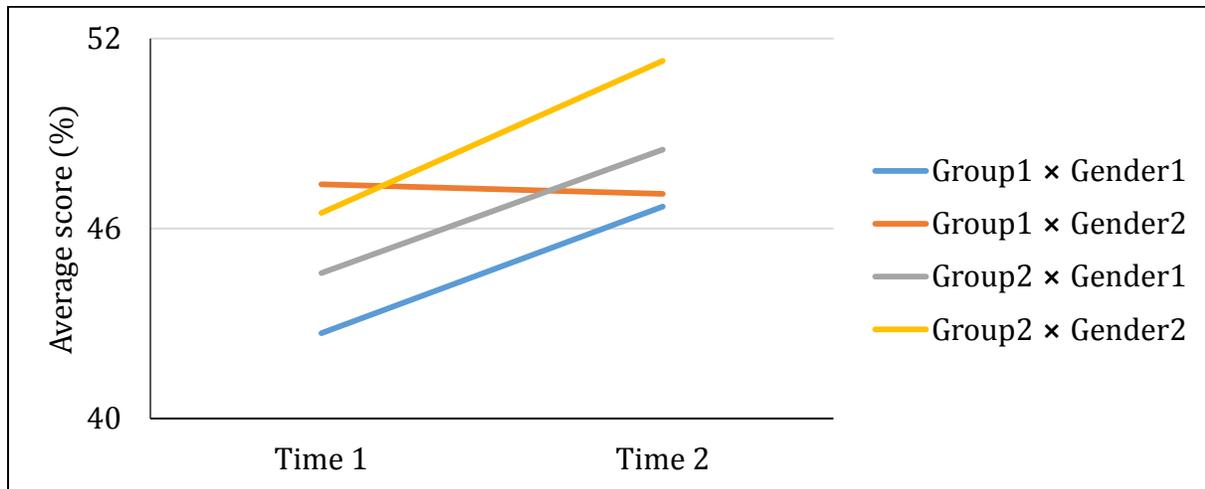
The first step in the analysis was to test for any significant interactive effects among the factors of Group, Gender, and Time – that is, to see if there were interactive effects on the scores from combining the three factors. Time was used to express the *pre-* versus *post* intervention factor. The p-value for the interaction was 0.267 with an effect size of 0.004, suggesting that there was no significant interaction between the 3 factors at any reasonable level of significance, and the effect size (practical significance) was negligible. According to Matheson (2008: 3), “effect size is a measure of the strength of the relationship between two variables.” Accordingly, he points out that “in a research setting, it is not only helpful to know whether results have a statistically significant effect, but also the magnitude of any observed effects.” Table 4.14 contains a summary of these interactions, which are illustrated in Figure 4.2.

Table 4.14: Group × Gender × Time Interactive Effects

	Pre-test	Post-test	P-value	Effect size
CC Group × Male	42.7 ± 2.2	46.7 ± 1.9	0.267	0.004
CC Group × Female	44.6 ± 1.9	48.5 ± 1.7		
CL Group × Male	47.4 ± 1.7	47.1 ± 1.5		
CL Group × Female	46.5 ± 1.8	51.3 ± 1.6		

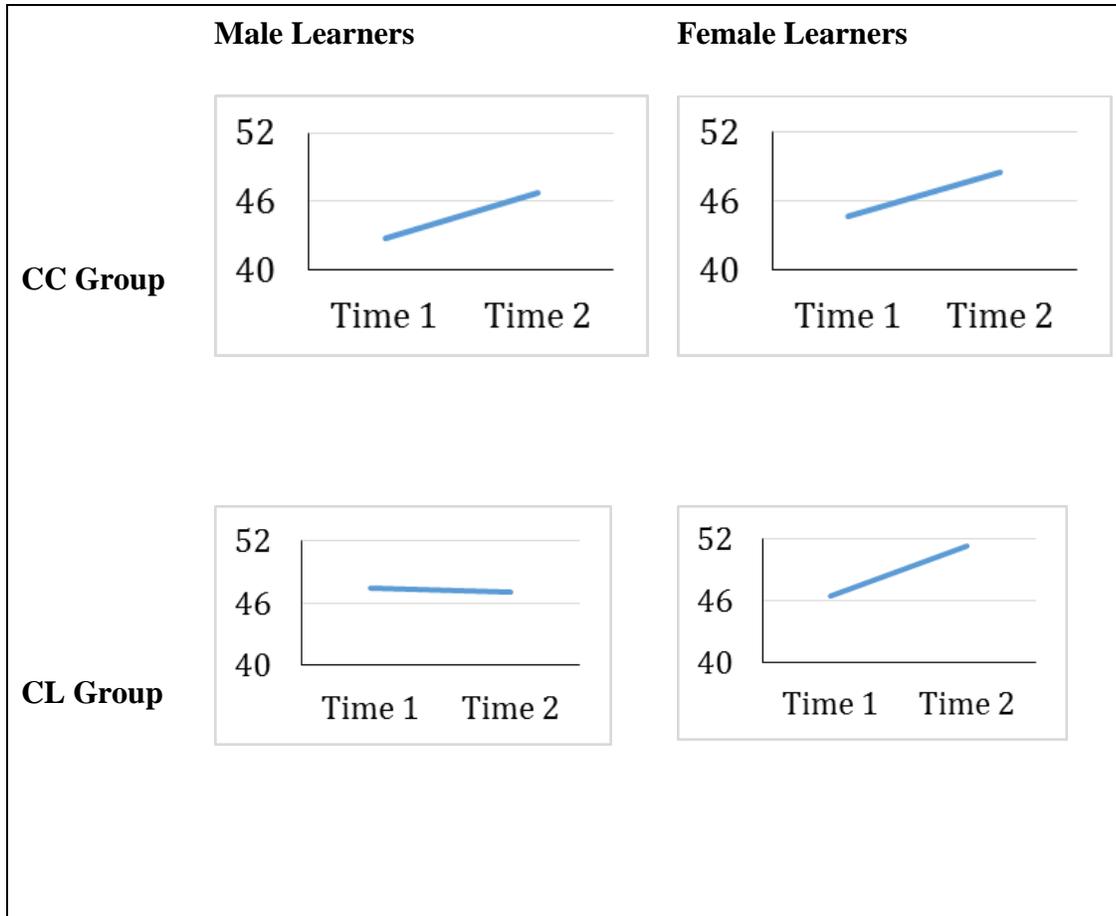
Figures 4.2, 4.3 and 4.4 represent the same information as shown in Table 4.14, but in slightly different ways for clarity and detail. Figure 4.2 illustrates the interactive effects between the CC Group (Group 1) and CL Group (Group 2) by gender and time of testing – where Time 1 is Pre-test and Time 2 is Post-test.

Figure 4.2: Group × Gender × Time Interactive Effects



Figures 4.3 and 4.4 illustrate the gains per treatment group, by gender between the pre- and post-tests, as reflected in Table 4.14.

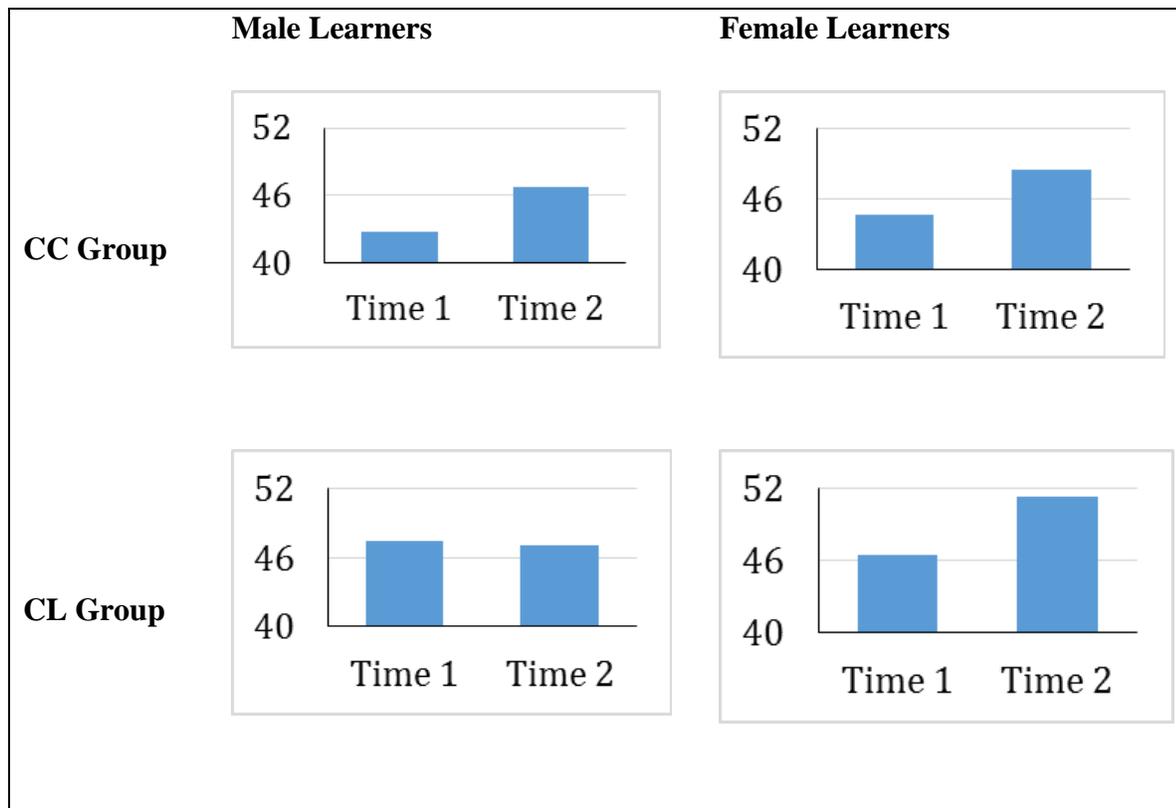
Figure 4.3: Group gains in scores between Pre- and Post-tests, by Gender



From Figure 4.3, it is evident that the only interaction that is slightly different is between Male Learners, CL Group and Time where no increase occurred as opposed to the other three where an almost identical change occurred.

Using a bar-graph representation (Figure 4.4) it is clear that between the pre- and post-tests, both male and female learners gained, except for the male learners of the CL Group.

Figure 4.4: Bar-graph representation of Group gains in scores between Pre- and Posttests, by Gender



Statistically, all the above four mean comparisons were put to the t-test statistic to determine whether or not the gains between the respective pre- and posttests were statistically significant at $\alpha = 0.05$. These comparisons are summarised in Table 4.15.

Table 4.15: Comparison of the pre-test versus post-test mean scores of the two groups

Group	Pre-test	Post-test	t-value	P-value	Result
CC Group Male Learners	42.70	46.70	-1.25	0.22	$p > 0.05$
CC Group Female Learners	44.60	48.50	0.25	0.80	$p > 0.05$
CL Group Male Learners	47.40	47.10	-1.89	0.06	$p > 0.05$

CL Group Female Learners 46.50 51.30 -2.33 0.02 $p < 0.05$

From Table 4.15, the only gain that was statistically significant was for the CL Group Female Learners.

In order to answer the third research question, the most important test was to determine whether or not the mean posttest score of the CC Group was significantly different from the mean posttest score of the CL Group. The results of this statistical comparison is presented in Table 4.16.

Table 4.16: Test of Significance between the CC and CL Treatment Conditions

	Pre-test	Post-test	P-value	Effect size
Conceptual Change Group	45.1 ± 1.4	46.9 ± 1.2	0.279	0.004
Collateral Learning Group	45.5 ± 1.3	49.9 ± 1.1		

Tables 4.15 contains the results of the two-way interactions, i.e., the main effects of time on the scores, as a result of the two treatment conditions. The p-values of 0.279 was not statistically significant at the 95% confidence interval, and the effect size was negligible. The *a priori* statistical hypothesis stated for this study was:

H₀: There is no significant difference in learner performance between those taught through a cognitive conflict-based conceptual change model versus those using an approach based on the collateral learning theory.

H₁: There will be a significant difference in learner performance between those taught through a cognitive conflict-based conceptual change model versus those using an approach based on the collateral learning theory.

Accordingly, the null hypothesis is accepted, suggesting that none of the two instructional approaches was better than the other. Figure 4.5 displays this information graphically.

Figure 4.5: Graphical representation of the performance of learners in the two groups.

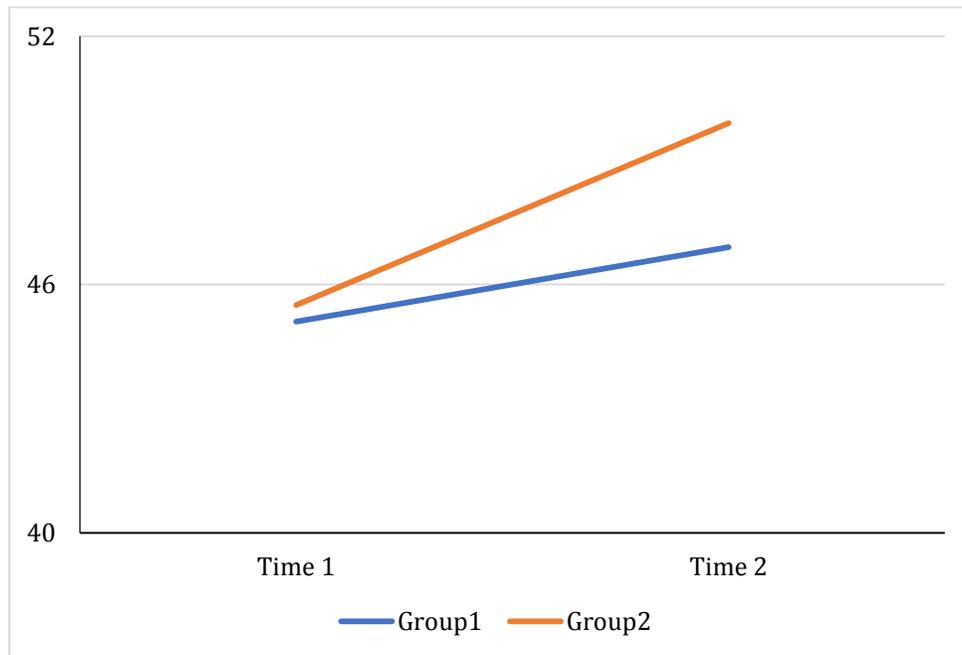


Table 4.16 and Figure 4.5 show that the gains by the collateral learning group (that is, Group 2) were higher than the ones made by the cognitive conflict-based conceptual change model (group 1). These gains were subjected to a t-test statistic, to test the following two respective null hypotheses:

A Posteriori Hypothesis 1: Conceptual Change Model

H₀: There is no statistically significant difference between the pre- and posttest scores of the learners taught through a conceptual change model.

H₁: There will be a statistically significant difference between the pre- and posttest scores of the learners taught through a conceptual change model.

A Posteriori Hypothesis 2: Collateral Learning Theory

H₀: There will be no statistically significant difference between the pre- and posttest scores of the learners following an instructional approach based on the collateral learning theory.

H₁: There will be a significant difference between the pre- and posttest scores of the learners following an instructional approach based on the collateral learning theory.

The t-test results of these of these two null hypotheses are presented in Table 4.17.

Table 4.17: Comparison of the pre-test versus post-test mean scores of the two groups

Group	Pre-test	Post-test	t-value	P-value	Result
Conceptual Change	45.93	46.98	-0.53	0.59	$p > 0.05$
Collateral Change	45.37	49.89	-2.96	0.003	$p < 0.05$

On the basis of the results presented on Table 4.17, the null hypothesis for Hypothesis 1 is accepted, meaning that the pre- and the posttests of the Conceptual Change Group were not statistically different from each other, thus, the comparison of the means yielded a non-significant result ($p > 0.05$). On the other hand, the null hypothesis for Hypothesis 2 is rejected, in favour of the alternative hypothesis, meaning that the gains made by the Collateral Learning Theory Group between the pre- and posttests were statistically significant. Thus, this shows that although the posttest scores for the two groups were not statistically significant from one another, the CL Group gained statistically significantly from their instruction. From this result, there appears to be justification to suggest that further research is needed to clarify the effect of these two approaches on the quality of learning. This study took place under very tight time constraints. The time which was available to cover all the topics prepared for the study was extremely short – that is, about four hours per week, over three weeks. The results do indicate that there is some qualitative value in using the collateral learning approach. It is possible that over a longer period of instruction, there may be a statistically significant difference in the gains between the two groups. Thus, although there was no statistically significant difference in the posttest scores of the two groups, the fact that the gains of the Collateral Learning Theory Group were statistically significant suggests that there is an important educational, or practical, significance associated with the collateral learning approach. As Filho, Paranhos, da Rocha, Batista, da Silva, Santos, and Marino (2013: 39) advise, “scholars must avoid interpreting the p

value statistic without graphically analyzing their data first.” Indeed, the graphical representation of the results sketched in Figure 4.5 suggested that there could have been some educational / practical significance in these results – and this is what the statistical testing proved. Practical significance refers to the empirical impact that an event may have in real life – whether or not statistical significance has been demonstrated. It is for this reason that “many editors and publishers are requiring authors to include some information surrounding the practical significance of their findings” (Matheson, 2008: 6). On the whole, what appears to be the main point is that both qualitative and quantitative ways of reporting results of this kind are important to give a more complete picture of the results.

4.6 SUMMARY OF THE RESULTS AND DISCUSSION

This discussion is broken into three sections in line with the research questions. First a summary of the results is presented, and then followed by a discussion of the results.

4.6.1 The Grade Three Learners’ Understanding of a ‘Healthy Environment.’

The first research question sought to establish grade three learners’ understanding of a healthy environment. Starting with the term ‘environment’, the results of this study have indicated that, at their level of schooling, the majority (100%) of the participants had achieved the expected level of conceptual understanding of the term – in line with the espoused content of the Foundation Phase curriculum. However, the view that the environment was something created by God brought up important pedagogic as well as policy issues.

On the definition of pollution, two categories of description emerged. Some learners gave responses which characterised pollution as some form or other of ‘contamination’, while others carried notions of pollution in relation to its consequences or effects. This latter propensity, that is, to characterise concepts within the context of their utilitarian value is typical of traditional communities. Knowledge always exists within a particular context and worldview, and this is what these learners were demonstrating. For instance, it is reported that scientific knowledge was grounded on indigenous worldviews before the emergence of Islamic science (during the Islamic golden age) (al-Khalili, 2011). The Islamic science was founded on Islamic worldviews and dominated the areas of mathematics and science from the mid-8th century to the mid-13th

Century, until the rise of Western science. Western science, which was founded on Ancient Greek worldviews, replaced and subsumed aspects of the Islamic science. The expansion of the European Empire through colonisation spread Western science across the world and this has become universally accepted knowledge. On the whole, however, it may be said that in this study the learners demonstrated familiarity with the concept of pollution.

The next two related concepts the learners were tested on were safe versus unsafe drinking water. Overall, the learners, again, gave a good account of themselves in terms of these two concepts. However, one main misconception that emerged was that one could contract HIV from drinking unsafe water. Following these two concepts, the next two items of the test were also related, namely ‘wasting water’ and ‘using water wisely.’ On both items, the results showed that the learners had a good grasp of the concepts, although, again, some possible misconceptions were noted. Similarly, the respondents demonstrated that they had a good conception of the 3R’s of recycling, re-using and reducing. However, on reducing, a couple of possible misconceptions were noted. Lastly, the results showed that the learners were quite aware of the various types of pollution and the various ways in which it affected both people and the environment. It may then be said, overall, that the general picture that emerged was that the grade three learners’ understanding of a healthy environment was quite good, and in line with their level of schooling.

These results agree with those obtained by Borg, Winberg and Vinterek (2017: 8) who reported that about half the preschool children in their research sample “described the word ‘environment’ as their world, their home or a place where all people can live,” including forests, flowers and grass. Furthermore, they also described environmental issues as either good or bad for the world and linked people to practices that contaminated / polluted the environment. Thus, the consequences of a polluted environment, which are reported in this study, were also highlighted by the children in the study by Borg, et al. (2017). In their study one child was reported to have said, “people should not throw any rubbish or pieces of glass. Animals can eat them and get problems or pain in their tummies. People should pick up rubbish and put it in the rubbish bin” (Borg, et al., 2017: 8). Indeed, we need to realise all the time that “living beings and the environment are in constant interaction with one another” and that, as a result, “the physical,

chemical and biological factors that constitute any given environment have a unique impact on particular habitats” (Gungordu, Yalcin-Celik and Kilic, 2017). Overall, “waste management is an issue where several technical, technological but also social and cultural factors contribute to make it complex, while the concentration of waste production in big cities mainly gives it an urban and metropolitan dimension” (Sgobbo, 2016: 6).

The results of this study further support the views expressed by Borg (2017: iv), that “by the time the children completed preschool, many had acquired some knowledge about how to use money, about the sorting of different recyclable items at home and at preschool, and about the impact of different modes of transport on the environment and people’s lives.” To Borg (2017: iv) such results as these “offer support for integrating environmental, social and economic dimensions of sustainability into the daily pedagogical activities of preschools and for giving children opportunities to participate in discussions and practical activities that concern their lives.” In concurrence, Borg, et al. (2017: 3) opine that:

... environmental issues have always been an integral part of children’s lives and that, therefore, these issues can be used as a starting point for children’s learning. Researchers have stressed the need for introducing issues related to sustainable development in early childhood education, acknowledging that children are capable of sophisticated thinking ... It is therefore of great importance to study how early childhood education – for example, preschool – influences children’s perceptions of sustainability issues, including the choice of various modes of transport.

Relating the discussion to the empirical studies presented in chapter two, it may be said that the learners in this study demonstrated awareness of the notion of ‘environment’ within the ecological perspective, in terms of which the term is construed as one in which individuals and groups of people are in equilibrium and harmony with their **physical, biological** and **social** environments (Piko and Bak, 2006: 643). Staying with Piko and Bak (2006:643), their study on Hungarian children revealed that the children had “considerable knowledge about health, illness and disease risks.” In Kenya, primary school children associated the concept of health with both biomedical and psychosocial aspects of life (Piko and Bak, 2006: 644).

Apart from investigating what the children understood by the term ‘environment,’ the researcher also unpacked this concept into a number of associated concepts that operate to characterise an environment. These other concepts included pollution (types and vectors), and further concepts associated with strategies which could be applied to redress the adverse effects of pollution, namely reduce, reuse and recycle. With regard to these concepts, the study showed also that the learners were familiar with the definitional aspects of these terms. However, as stated earlier, some of the learners contextualised their definitions within the context of human actions which bore certain consequences on the well-being of Planet Earth.

In an earlier study, Kahriman-Öztürk, Olgan and Güler, 2012: 2994) reported that preschool children showed familiarity with the terms reduce, reuse, recycle – ostensibly learnt from their many experiences with practical situations where these concepts were used in Sweden. No such studies appear to have been carried out in South Africa. Accordingly, the researcher hopes that the current study will stimulate similar studies in order to find out how much early learners (that is, those in the Foundation Phase of the school system) understand about the environment, the threats to its well-being, and how these threats could be mitigated.

As observed earlier, one of the contributions of this study, insofar as learners’ responses to the first research question are concerned, was the learners’ characterisations of the various concepts in terms of their associated consequences. So, in addition to stating that the term environment referred to “all the things around us,” some learners were able to state how certain human actions would likely adversely affect the environment, as well as the ‘living things’ which depend on that particular environment. In addition, some possible misconceptions, or at least some misunderstandings, also emerged from the study. These included the following:

- Environment – *It is God’s creation*, raised both pedagogic and policy issues.
- Pollution is sickness
- Pollution means infecting other people with your illness.
- Worms come from the land if polluted
- Safe / clean drinking water gives people power
- Safe / clean drinking water cleans all germs in the body

- Drinking safe or clean water makes one's heart healthy
- A person can contract HIV from unsafe drinking water
- Drought is caused by wasting water

Overall, it was quite commendable that the learners came up with the notion of vectors, and the adverse effects of their actions on the environment, plants, people and other life-forms. The learners also appeared to have a good sense of the different types of pollution. However, they seemed not to be clear about the concepts of reducing and reusing, particularly the distinction between the two.

From the point of view of collateral learning theory, mis- and alternative conceptions need to be handled with deliberate and well-considered carefulness, considering that the learners' home knowledge must be respected and appropriately affirmed. Failure to do so may perpetuate the same mis- and alternative conceptions, and may lead to ways that are typically associated with superficial or surface learning because deeper probing of concepts has not been done to achieve deeper learning. Nonetheless, as Rymarz (2012: 79) remarks, "good teachers will always try to situate new learning within students' prior knowledge" and therefore prior experiences. So, "ultimately, as with all decisions about pedagogy, what is 'best' depends on the instructional situation: the goals of the learning experience, the attributes of the students, the type of content, and the timeframe and resources available" (Dede 2008: 52).

4.6.2 Explanations Behind the Learners' Responses about a Healthy Environment

The second research question sought to explore the explanations which lay behind grade three learners' understanding of a healthy environment. Individual and focus-group interviews were conducted to elicit explanations related to selected concepts about a healthy environment. The concepts were (a) recycling, (b) water pollution, (c) land / soil pollution, (d) unsafe and safe drinking water, (e) air pollution, (re-using (tested by Pictures 6 and 8), (f) noise pollution. The interviews focused on whether or not the learners could (a) identify the type of adverse environmental factor depicted in the picture, and (b) explain how that factor effected (i) the environment and/or (ii) the health of life supported by, or dependent upon, that environment.

On Picture 1, there was nothing in their explanations given by the learners to suggest that they associated what they observed in the picture with the notion of recycling. This result was surprising because in their answers to the first research question, they demonstrated that they understood the concept of fairly well, however, that was at the definitional level. It appeared that the application of this concept remained a challenge to them. Their explanations centred around the social benefits of what they observed in the picture, namely to provide shoes to poor people. Perhaps at the grade three level, this is a way of acknowledging the importance and benefits of 'recycling.' The researcher expected the learners to say that the tyres had served their original purpose; they were now worn out and could no longer serve that original purpose, and that the picture showed how something that has been thrown away by one user could serve as a valuable resource for another one. Secondly, that in the context of the environment this had some benefits, both for the environment itself and some socio-economic benefits as well, in addition to a healthy environment. As Friends of the Earth (2008: 2), opine, "recycling reduces the need for raw materials such as metals, forests and oil and so reduces our impact on the environment." Singh, Cranage and Lee (2014: 13) expand on the benefits of recycling as follows:

Most human activities create waste, and the way this waste is handled, stored, collected and disposed of can pose risks to the environment and to public health ... With the increase of business activities as well as rapid urbanization, the generation of waste has also increased. Improper management of this waste has led to various hazards not only for human beings but also for the whole ecosystem. Recycling has been at the forefront of successfully managing the problem related to waste. It is one of the processes that is used in Integrated Solid Waste Management (ISWM) along with reduce and reuse.

Regarding water pollution (Picture 2), there was sufficient evidence that the learners made the connection between the picture and water pollution. Further, they were able to explain how water affected living organisms (in this case fish) which depended on that environment. In addition, and by extension, they went on to state that the fish was killed by the dirty water, and that if people ate the fish, they would get sick – or even die.

With regard to land or soil pollution (Picture 3), there was a demonstration that the learners were *au fait* with what it was, and its consequences – both on the environment and on human, animal and plant life. The learners in this study were able to identify a number of hazardous aspects of the dumping site, including the gases emitted from the burning ‘plastics’, and the likelihood of the children playing at the dumping site catching some diseases as a result of the dirty environment around the dumping site. The problem is that as landfill sites fill up, there is more pressure “to use new sites with the loss of that land use for housing, leisure or agriculture; and the additional waste left in these landfill sites increases air, water and land pollution” (King, Burgess, Ijomah and McMahon, 2006: 257). This view is supported by Bekin, Carrigan and Szmigin (2007: 271) who make the observation that “growing amounts of waste are critical environmental threats; crammed landfills, contaminate the soil and streams, and pollute the air.”

Overall, on the several pictures dealing with pollution, the learners appeared to be quite clear about what pollution was, and even about the consequences of the various types of pollution. So, the results of this study support earlier studies, where it was found, for instance, that in general, children “seemed to know that harmful gases from cars and buses cause air pollution, which they could relate to the extinction of life and damage to the planet and which are identified as challenges for social sustainability” (Borg, 2017: 72). In the present study, learners were asked to study a picture showing gas emissions and smoke coming from an industrial site (Picture 5), and they demonstrated familiarity with air pollution and its effects / consequences, particularly on human and plant life. Similar responses were obtained concerning noise pollution, revealing that the learners were adequately *au fait* with both what it (noise pollution) was and its effects / consequences on living things, in particular.

The learners in this study were quite quick to distinguish between safe and unsafe drinking water, and give satisfactory explanations about the adverse effects of drinking polluted water (Picture 4). In Pakistan, “drinking water sources, both surface and groundwater are contaminated with coliforms, toxic metals and pesticides throughout the country” (Azizullah, Khattak, Richter, and Häder, 2011: 479). They further aver as follows:

Human activities like improper disposal of municipal and industrial effluents and indiscriminate applications of agrochemicals in agriculture are the main factors contributing to the deterioration of water quality. Microbial and chemical pollutants are the main factors responsible exclusively or in combination for various public health problems. (Azizullah, et al., 2010: 479).

According to Schwarzenbach, Egli, Hofstetter, von Gunten and Wehrli (2010: 109), “water quality issues are a major challenge that humanity is facing in the twenty-first century.” They further surmise that “many of the major problems that humanity is facing in the twenty-first century are related to water quantity and/or water quality issues’ and “these problems are going to be more aggravated in the future by climate change, resulting in higher water temperatures, melting of glaciers, and an intensification of the water cycle, with potentially more floods and droughts (p. 110). These problems will pose certain challenges to human health, the most direct and most severe of which will be “the lack of improved sanitation, and related to it is the lack of safe drinking water, which currently affects more than a third of the people in the world” (Schwarzenbach, et al., 2010: 110). Thus, it is of paramount importance that as early as possible children are sensitised about the many dangers that lurk in untreated, unsafe drinking water. It was quite comforting that the learners in this study appeared to be well informed about safe *vis-à-vis* unsafe drinking water. However, it should also be mentioned that a few misconceptions also emerged from some of their explanations. These included the notions that one could catch TB from drinking dirty water, and that drinking clean water resulted in someone having enough blood. As recommended earlier, these misconceptions will have to be addressed appropriately and with due sensitivity.

On re-using (Pictures 6 and 8) it could be said that this concept was partially understood. Although the learners were able to recognise that the plastic containers in Picture 6, and used tyres in Picture 8, were being re-used, the interviews could not reveal what the learners understood to be the underlying environmental benefits of these actions which amounted to re-using. Perhaps the difficulty is traceable to the learners’ inability to recognise Picture 1 as illustrating recycling. Nonetheless, Picture 8 brought out the concept of adaptive reuse (Sarafides, 2007: 1), where the structure of an original object is ‘processed and modified’ to suit

its adapted use. In the case of the tyres, they were painted (some aesthetic value added to them) and then used for a different purpose – that is, to serve as flower pots.

The concepts reduce, reuse and recycle are related concepts which “people everywhere are starting to understand and apply to everyday life” because the underlying principles “are quite basic, but are a necessity for maintaining a sustainable life” (Bushnell, Harpster, Simchuk, Manckia and Stevens, 2011: 1). In their study, Kahriman-Öztürk, Olgan and Güler (2012: 2994) found that “preschool children expressed their ideas about reduce, reuse, recycle and respect dimensions while they did not mention redistribute, reflect and rethink.” They attributed the children’s familiarity with these concepts to “their having many experiences about these more concrete concepts in preschool settings” (p. 2994).

The focus of the interviews, as opposed to the paper-and-pencil test used to address the first research question, was to deepen the responses and establish the extent to which the learners understood the underlying concepts associated with certain activities, as demonstrated in the pictures they were asked to study. In this regard, on Picture 1, the learners appeared to find it difficult to articulate their answers clearly in line with the notion of recycling. It is possible that if a different, more familiar picture, such as Picture 9 were used, maybe this would have elicited a different reaction from the learners.



Picture 9

Nonetheless, this was an application task, and the interviews failed to bring out an explanation which would have given the researcher the sense that the learners understood the concept of recycling from the picture they were given to study.

On the other concepts, there appeared to be consensus that the learners were reasonably familiar with them. Accordingly, it may be stated that from the policy point of view, it is a good idea that the topics about the environment are included in the Foundation Phase curriculum in order to ensure that the right mind-sets about the environment are established early in the learners' educational career. There is no doubt that formal education plays an important role in orientating children about the environment. As Broström (2012: 4) observes, today education cannot only be seen as a qualification and socialisation process, but also as a subjectification process whereby children are educated "to be autonomous and independent in thinking and action." In this regard, Whitebread, Kvalja and O'Connor (2015: 6) observe that "there is strong and consistent evidence that high quality Early Childhood Education (ECE) impacts children's academic development and their emotional and social well-being more powerfully than any other phase of education." This view is supported by Borg (2017: 1-2) in his observation that "there is evidence that high-quality early childhood education is effective in developing young children's attitudes and forming their behaviors as well as in having positive effects on children's well-being, health, and intellectual and social behavioral development, especially in terms of children from disadvantaged backgrounds." Borg (2017: 1) further stresses this point in his observation that "learning during the early stages of life is considered to be important as individuals in our society carry within themselves patterns of feeling, thinking and acting that they learned when they were young." Whitebread, Kvalja and O'Connor (2015: 6) concur with this view in their statement that "there is strong and consistent evidence that high quality Early Childhood Education (ECE) impacts children's academic development and their emotional and social well-being more powerfully than any other phase of education."

The importance of introducing young children to these important concepts concerning the environment cannot be over-emphasised, considering that once "patterns have been established in people's minds, it is difficult to unlearn them." (Borg, 2017: 1). This does not only pertain to young learners, but to the general population as a whole – as Borg, Winberg and Vinterek

(2017b: 1) explain, “changing the values and norms of a culture, and ultimately the behaviour of the individuals within it, is a daunting task that requires adults not only to change their way of thinking, but also to convey this way of thinking to younger generations, as their attitudes are influenced by the norms and values of socializers.”

It is pleasing when children as young as the ones who participated in this study demonstrate the knowledge of, and familiarity with, these basic but important environmental concepts, especially considering that “environmental challenges are likely to increase over the next decades and could even threaten children’s very future on the planet” (Committee on the Rights of the Child, 2016: 5). In Sweden, “preschools are expected to include educational activities highlighting nature and environment, as well as to work with democratic values as a foundation for learning and social interactions” (Borg, Winberg and Vinterek, 2017: 153).

4.6.3 The Cognitive Conflict-Based Conceptual Change Instructional Approach versus the Collateral Learning Theory Instructional Approach

The third research objective sought to find out whether or not there would be a statistically significant difference in performance between learners taught through a cognitive conflict-based conceptual change model versus those using an instructional approach based on collateral learning theory. Both were based on the constructivist pedagogy which, according to Tan (2016: 5) is often associated with a “stress on the exploration and application of knowledge in real life, encouraging students to proactively solve inter-disciplinary problems, expecting teachers to promote interaction and cooperative learning, and highlighting the need for formative assessment.” The main limitation, however, is usually that more often than not, the learners’ home knowledge and understandings are neglected. It is important to do this because “many of the conceptions which learners bring to the classroom have their background in culture, religion, and superstitions” (Kola, 2017: 59). These learner characteristics are important to the identity of the individuals concerned. Thus, to neglect the knowledge these individuals bring to the classroom appears to be not only unrealistic but an injustice. This was the basis for the decision to affirm the collateral learning theory in this study.

Typically, protagonists of the cognitive conflict- based conceptual change stress the scientific way of thinking. Consequently, the conceptual conflict they advocate is manifests in terms of discrepant thinking vis-à-vis the scientific way of doing science and understanding concepts. As Crawford and Capps (2016: 1) argue “teachers need to have integrated knowledge of science concepts, science practices, nature of science, and pedagogy, as well as a metacognitive stance towards their teaching to support inquiry in the classroom.” There is no mention of indigenous or home knowledge, as well as affective characteristics of the learners to be important aspects of this pedagogy. It is all about *scientific practice and knowledge* – an all-or-nothing attitude.

According to Liu (2010: 181), conceptual change is essential for meaningful learning, and *cognitive conflict* is considered a premise for conceptual change. Cognitive conflict occurs when an individual can not apply their existing concept to solve a problem, and is thus confronted with a situation that motivates the learning of new concept (Liu, 2010: 181). This was the basis for the conceptual change treatment group. On the other hand, the collateral learning theory was also an attractive proposition because of its stress on the importance of traditional / home knowledge of the learners in attempting to advance their understanding and knowledge about things.

From the school science point of view “the importance of identifying children’s home knowledge and understanding has been emphasized on many occasions in literature” (Vitharana 2015: 276). As Galvin, et al. (2015: 2) point out, “biology misconceptions have been recognized as a major factor affecting the students’ understanding of science at the secondary school level with many misconceptions carried onwards to university studies.” In order to address this, Vitharana (2015: 276) is of the view that “teachers need to know ideas of scientists about the concepts to be taught as well as the misconceptions of students in order to promote effective science teaching.” However, teachers may be in a position to know the ideas that scientists have about many of the concepts they teach, but often neglect to find out the ideas which the learners have already accumulated from their communities about the same concepts. It is even possible that some of the teachers do not see much value in spending their valuable time trying to find out what scientific ideas learners bring to the classroom.

To establish which one of the two instructional approaches was more effective in teaching the selected topics, the two respective posttest mean scores were compared. The result was that although some gains had been made by both groups, there was no significant difference, statistically, between the two posttest mean scores. However, it was established that using the pretest scores as baseline, the collateral learning group had performed statistically significantly beyond the pretest, suggesting that there was some merit in thinking that collateral learning could be a productive approach to use in South African schools. Indeed, as Kola (2017: 59) concludes, the “teacher should promote student interactions and respect student ideas: being the kernel of constructivist learning.” The posttest mean score of the cognitive conflict-based conceptual change group was not significantly different from the pre-test mean score.

This result suggests that more research is still needed to give clarity to this matter. The conceptual models used to distinguish between the two approaches were largely similar because all learning involves conceptual change, and conceptual learning theory does not rule out the cognitive-conflict perspective of learning, but only adds to it. The distinguishing conceptual models used to operationalise the two instructional approaches (see Figures 3.1 and 3.2), only differed on one factor – *indigenous knowledge structure and lived experience*. The remaining five factors were commonly shared between the two approaches. Thus, the main distinguishing feature of the collateral learning approach was to give recognition, time and space to the learners’ home knowledge and lived experiences to be considered in the implementation of each lesson. Apart from making cognitive sense to teach learners by affirming and building on what they already knew from home or their communities, it was also envisaged that such an approach would motivate them.

Quite interestingly – *albeit* expectedly, this study also revealed the propensity by some African learners to fall back on holistic thinking, which is typically characterised by context. As Varnum, Grossmann, Kitayama and Nisbett (2010: 9) aver, the holistic learning style is its “broad attention to context and relationships.” This surfaced in the various questions where the learners were asked to explain their understanding of the various environmentally-related

concepts. Many ‘definitions’ were coined in terms of the consequences of the concepts – which typified contextual thinking.

According to Dede (2008: 50) “people construct new knowledge and understandings based on what they already know and believe which is shaped by their developmental level, their prior experiences, and their sociocultural background and context”. In the African context, people take their time to explain things, always building an elaborate **context** for their explanations, no matter how small the task.

Context-based learning is associated with the field of cognitive styles. Different people have different ways of thinking, and research around cognitive styles addresses this issue by attempting to unpack how people with different patterns of thinking approach problems. The point that people have different cognitive styles contracts the historical assumption that human cognition and perception are universal among people of all cultures – as Nisbett and Mitamoto (200: 472) explain, “the cultural environment, both social and physical, shapes perceptual processes.”

One of the most common distinctions in the literature on cognitive style is between *analytic* and *holistic* styles, where the former involves understanding a system as by thinking about its parts and how they work together to produce larger-scale effects, whilst the latter refer to a disposition towards using experience-based knowledge rather than abstract logic. As things turn out, whereas Westerners tend to engage in **context-independent** and analytic perceptual processes by focusing on a salient object independently of its context, Asians and Africans tend to engage in **context-dependent** and holistic perceptual processes by attending to the relationship between the object and the context in which the object is located. Thus, with regard to the implications of this for classroom practice, what it means is that people belonging to the two cognitive styles will require different learning environments in the kinds of information that is provided in order to learn optimally. Learners with a holistic cognitive style will prefer a learning environment that is rich with information that shows relationships among concepts or concepts connected into a meaningful whole, whereas analytic thinkers will prefer focused and categorized information. The implication of this is that teachers’ efforts should centre around helping students to

“experience various modes of meaning-making and communicating and to create a community in which multiple ways of learning take place as opposed to the largely cultureless mode of learning which dominates schools” (Takaya, 2008: 2). In this regard, Takaya exalts “the importance of understanding culture as *context* in which values and meanings of students’ experience may be interpreted.”

Since the 1970s, there has been a preponderance of research on the effects of learners’ pre-existing knowledge as well as alternative conceptions on subsequent learning (Treagust 1988; Veiga 1989; Wandersee et al. 1994; Akerson et al. 2000; Prokop et al. 2007; Coetzee 2009; Mchunu 2012; Rankhumise 2012). Overall, these studies have reported that “school children can proceed through their school careers and retain misconceptions about many science concepts,” suggesting that “in the absence of a teacher who understands and uses knowledge of children’s ideas to inform instruction, children are unlikely to develop their ideas towards scientific understanding” (Akerson et al. 2000: 364). To Akerson et al. (2000: 364) this is evidence that “the kinds of science instruction children receive do not seem to be effective in helping students change their conceptions of science” and that “students may be presented with evidence that their ideas are incongruent with an experiment or problem and reject the evidence, or interpret it differently within their own beliefs ...” Thus, the solution appears to lie in studying and understanding children’s prior knowledge as a vital input into the instructional process, especially considering that learning takes place from what someone knows (or purports to know) to what is new. It is therefore important that teachers take into account the ideas learners bring to the classroom concerning the phenomena to be learned, in order to improve classroom practice. As Aikenhead (1996: 2) aptly points out, “if only we could understand how students make sense of their natural world, we could design a science curriculum so that science makes sense to all students.”

These are the arguments which led to this study because in operationalising collateral learning, the main issues which came up related to the importance and significance of the learning context – together with the knowledge and understandings which learners bring to the classroom. The results of this study suggest that it was educationally justified for this approach to be tried out.

Future research in this field could help clear up some of the uncertainties which still linger after the results reported in this study.

4.7 A MAJOR LIMITATION

Classroom-based research is quite difficult to undertake because, almost invariably, one has to depend on classroom teachers who are already set in their ways, and who may not be very easy to persuade to adopt different ways of doing things. An external intervention like this one is often seen as an interference in the normal run of things for the particular classes involved. Understandably, there is always pressure on teachers to cover the prescribed curriculum within the prescribed timeframes. Nonetheless, one has to be grateful to them for offering to assist with one's investigation.

4.8 CONCLUSION

In conclusion, the researcher is satisfied that, within the stated constraints, much was achieved, and the results reported in this chapter will go a long way in serving as baseline data for future research. On the first research question, the learners were found to be fairly well-informed about the concepts which they were tested on, notwithstanding that there were some mis- or alternative conceptions that emerged. The purpose of the second research question was to deepen the learners' responses on the answers which they provided to the first research question. The individual and focus group interviews used to address the second research question provided further insights into the thinking of the learners about the concepts in question. Overall, the researcher was quite impressed by the responses given by the learners. This shows that a good foundation was laid for subsequent grades to build upon – yet again, being mindful of the mis- and/or alternative conceptions which the learners may have.

In response to both the first and second research questions, the issues of context-based learning and the associated holistic cognitive learning style emerged and manifested themselves in the definition of concepts in terms of their effects on the environment and attendant life forms – plants, humans and animals, as the case may be. In the process, this demonstrated the learners' understanding of a healthy environment – which was the main focus of the study.

On the third and final research question, the result was not conclusive in the sense that although the Collateral Learning Learners Theory group improved significantly over its pretest scores, its overall gains were not significantly different from the gains made by the Cognitive Conflict-Based Conceptual Change group, as determined by the comparison of the posttest scores of the two groups. There is still need for further research on this matter.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter summarises the study as a whole, draws conclusions from the study and its findings, and presents some recommendations.

5.2 SUMMARY OF STUDY

This study was conducted within the King Cetshwayo District of the Province of KwaZulu Natal, South Africa. Altogether, four schools offering Foundation Phase education were involved, giving a total of three hundred and twenty-eight learners. For reasons of accessibility, the study was confined to the Nseleni, Richards Bay and Esikhaleni education circuits.

The purpose of this study was to explore grade 3 learners' understanding of a healthy environment, and compare the effectiveness of teaching approaches based on the cognitive conflict-based conceptual change perspective versus collateral learning theory, in helping grade 3 learners to achieve espoused learning outcomes. Specifically, the study set out to answer three research questions, namely:

- a) What conceptions do grade three learners have of the construct of a healthy environment?
- b) What explanations lie behind the learners' conceptions of a healthy environment?
- c) Will there be a statistically significant difference in learner achievement between those taught through a cognitive conflict-based conceptual change approach versus those taught through an instructional approach based on Collateral Learning Theory?

The theoretical basis of this study was built upon literature which pointed to the urgent and quite important issue of the threat to a healthy environment, reflected against the devastating effects of the human civilisation's plunder of Planet Earth. This was followed by a look at some studies which have reflected on the views and perceptions of learners about the notion of a healthy environment. This literature prepared the way to look at the various perspectives about conceptual change as well as the collateral learning theory – and the implications of both for teaching and learning. Elements of these perspectives, namely smooth, managed, hazardous, and impossible border crossing were integrated with Vygotsky's theory of the Zone of Proximal Development to consummate a conceptual framework for this study. To this end, the researcher believes that she has made a significant contribution to the field through the conceptualisation of this model.

The research methodology of the study was situated within the mixed methods research paradigm, meaning that both qualitative and quantitative data were collected. As a mixed methods research project, there were two designs applied. The first was a Case Study design, formulated to address the first two research questions. The second research design was the Non-Equivalent Groups quasi-experimental research design, which was directed towards addressing

the third research question. Simple random sampling was used to select the four participating schools from these Circuits.

There were several research materials / instruments used in this study. First, supplementary learning support materials were developed to support and give guidance to the teachers and learners. The second research instrument was an interview schedule which was used to explore the grade three learners' understanding of a healthy environment and explore the explanations which lay behind their understanding of a healthy environment. The third research instrument was the pre-test which was used to establish the baseline knowledge that the learners had about a healthy environment. The same test also served as a posttest to measure the comparative gains that the learners had made following the two respective interventions. Data collection involved individual and focus-group interviews with learners, as well as the use of a written test. The use of focus group interviews helped the researcher to maximise on learner participation, resulting in forty-eight learners participating in the interviews, in addition to twenty-four who participated in individual interviews. The written test was administered in the usual way as class tests. Permission was requested and obtained to have all the interviews voice-recorded so that the interviewers could focus on the conversations with the learners rather than, for instance, on note-taking.

Qualitative data arising from the administration of the interview schedule were analysed based on the hermeneutical approach. The first stage of data analysis involved reading through all the transcripts of the learner responses and creating categories of description to represent emerging themes. This entailed finding patterns from which the themes and conceptual categories could be constructed. In a reiterative process, the recurring themes and conceptual categories were progressively reduced in number by combining conceptually similar ones, resulting in a consolidated, fewer numbers of categories of descriptions. Quantitative data were analysed statistically using the Statistical Product and Service Solutions (SPSS). The analysis involved a comparison of the means as a result of the two interventions. In this regard, either the Analysis of Variance (ANOVA) and the t-test statistic were used.

The results of the study were as follows:

First Research Question

The first research question sought to establish grade three learners' understanding of a healthy environment. Starting with the term, the results of this study have indicated that, at their level of schooling, the majority (100%) of the participants had achieved the expected level of conceptual understanding of the term 'environment' in line with the espoused content of the Foundation Phase curriculum. However, the view that the environment was something created by God brought up important pedagogic as well as policy issues. On the definition of pollution, two categories of description emerged. Some learners gave responses which characterised pollution as some form or other of 'contamination', while others carried notions of pollution in relation to its consequences or effects. This latter propensity, that is, to characterise concepts within the context of their utilitarian value is typical of traditional (African) communities. Knowledge always exists within a particular context and worldview, and this is what these learners were demonstrating. On the whole, it may be said that the learners demonstrated familiarity with the concept of pollution.

Furthermore, the results showed that the learners understood the concepts of *safe drinking water*; *unsafe drinking water*; *wasting water*; *using water wisely*; *land/soil, air, water and noise pollution*, well as the 3R's of *recycling*, *re-using* and *reducing*. However, a few possible mis- and/or alternative conceptions were noted. Overall, the general picture that emerged was that the grade three learners' understanding of a healthy environment appeared to have met the expectations of the curriculum, and was in line with their level of schooling.

Second Research Question

The second research question sought to explore the explanations which lay behind grade three learners' understanding of a healthy environment. Individual and focus-group interviews were conducted to elicit explanations related to selected concepts about a healthy environment. The concepts were (a) recycling, (b) water pollution, (c) land / soil pollution, (d) unsafe and safe drinking water, (e) air pollution, (re-using (tested by Pictures 6 and 8), (f) noise pollution. The interviews focused on whether or not the learners could (a) identify the type of adverse

environmental factor depicted in the picture, and (b) explain how that factor effected (i) the environment and/or (ii) the health of life supported by, or dependent upon, that environment.

From the results, there was nothing in the explanations given by the learners to suggest that they associated what they observed in the first picture with the notion of recycling. This result was surprising because in their answers to the first research question, the learners demonstrated that they understood the concept fairly well. However, that was at the definitional level, and now it was at an application (or at the least, Comprehension) level of Bloom's taxonomy.

Overall, on the several pictures dealing with pollution, there was sufficient evidence that the learners made the connections between the respective pictures and water, land/soil, air, and noise pollution, including explaining how these types of pollution affected living organisms (in this case fish) which depended on the particular environment form. pollution, including explaining how water affected living organisms.

The learners were quick to distinguish between safe and unsafe drinking water, and give satisfactory explanations about the adverse effects of drinking polluted water (Picture 4). It is of paramount importance that as early as possible children are sensitised about the many dangers that lurk in untreated, unsafe drinking water. However, it should also be mentioned that a few misconceptions also emerged from some of their explanations. These included the notions that one could catch TB from drinking dirty water, and that drinking clean water resulted in someone having enough blood. As recommended earlier, these misconceptions will have to be addressed appropriately and with due sensitivity.

On re-using (Pictures 6 and 8) it could be said that this concept was partially understood. Although the learners were able to recognise that the plastic containers in Picture 6, and used tyres in Picture 8, were being re-used, the interviews could not reveal what the learners understood to be the underlying environmental benefits of these actions which amounted to re-using. Accordingly, it may be stated that the learners understood the concept of 'environment' as prescribed by the Foundation Phase curriculum.

Third Research Question

The third research question sought to find out whether or not there would be a statistically significant difference in performance between learners taught through a cognitive conflict-based conceptual change model versus those using an instructional approach based on collateral learning theory. To establish this, the two respective posttest mean scores were compared. The result was that although some gains had been made by both groups, there was no statistically significant difference between the two posttest mean scores. However, it was established that using the pretest scores as baseline, the collateral learning group had performed statistically significantly beyond the pretest, suggesting that there was some merit in thinking that collateral learning could be a productive approach to use in South African schools. The posttest mean score of the cognitive conflict-based conceptual change group was not significantly different from the pre-test mean score. This result suggests that more research is still needed to give clarity to this matter. Partly, the reason for this is that the conceptual models used to distinguish between the two approaches were largely similar because all learning involves conceptual change, and conceptual learning theory does not negate the cognitive-conflict perspective of learning, but only adds to it. The distinguishing conceptual models used to operationalise the two instructional approaches only differed on one factor – *indigenous knowledge structure and lived experience*. The remaining five factors were commonly shared between the two approaches, namely *aim of instruction, learner prior knowledge, instructional methods, learner interest and self-concept, and structure of science content*.

5.3 CONCLUSION

Within the stated constraints, the researcher is satisfied that much was achieved, and that the results reported in this study will go a long way in serving as baseline data for future research. Overall, the researcher was quite impressed by the responses given by the learners. This showed that an appropriate foundation was laid for subsequent grades to build upon – yet again, being mindful of the mis- and/or alternative conceptions which the learners may have. In retrospect, what became clear as the study progressed was that the study had attempted to investigate too many concepts at the same time. Consequently, both the test and interviews appeared to be too long for the learners. The time available to teach the selected concepts also turned out to be too

short. Nonetheless, the researcher contends that the results of the study will be useful to both classroom practitioners and other researchers. In the opinion of the researcher, apart from the results reported in this study, the researcher believes that she has made significant contributions to the field from the point of view of the conceptual frameworks developed in this study – one in chapter two and two in chapter three. It is envisaged that these models could contribute to a deeper understanding of the concepts and principles involved in both cognitive conflict-based conceptual change and collateral learning theory.

5.4 RECOMMENDATIONS

From the observations and results reported in this study, several recommendations may be made:

- 5.4.1 Presently, it seems not much research has been carried out in South Africa involving Foundation Phase learners' understanding of a healthy environment, thus, the researcher could not compare these findings to any prior research in the country. The researcher hopes, therefore, that other researchers will enter the fray and contribute by undertaking similar research, especially considering the importance of this topic.
- 5.4.2 On the learners' understanding of the selected concepts about a healthy environment which were investigated in this study, several mis- and/or alternative conceptions emerged. This shows that misconceptions or alternative conceptions start to form early from learners' experiences. Education practitioners (that is, curriculum planners, subject advisers and school-based educators) are advised to take note of these concepts and devise strategies to address them appropriately and adequately, *albeit* with due sensitivity bearing in mind the arguments concerning collateral learning.
- 5.4.3 The results to the third research question suggested that there is some merit in teaching according to the collateral learning theory model. Classroom practitioners are asked to consider teaching according to his model in order to validate or negate this instructional approach. The finding that the collateral learning group performed significantly higher in the posttest, compared to the pretest, justifies such an effort.

- 5.4.4 Owing to the inconclusive nature of the findings to the third research question, researchers are urged to replicate this study, with a view to clarifying the efficacy of these two instructional approaches.
- 5.4.5 From the curriculum planning point of view, it is very important to look into the issues of analytic versus holistic cognitive styles, as these have major implications for the way learners engage with the concepts prescribed in the curriculum. It is akin to a tragedy that most post-colonial countries have inherited and retained curricula which are based on analytic cognitive sets when the majority of learners and communities engage with problems using a holistic cognitive set.

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ANNEXURES

FORM A: Department of Health Application for Ministerial Consent for Non-Therapeutic Research with Minors

1. INSTRUCTIONS

- 1.1 This application form must be completed for all protocols that are classified as “non-therapeutic” and involve the participation of minors.

Non therapeutic research is defined in the regulations relating to research on human participants as “research that does not hold out the prospect of direct benefit but holds out the prospect of generalizable knowledge.” Minors are defined as person under the age of 18 by Section 17 of the Children’s Act, 2005 (Act No. 38 of 2005).

- 1.2 This application form should be submitted with a copy of the protocol and supporting documents.
- 1.3 This application should be submitted to the Minister of Health or the delegated authority in terms of Section 92(a) of the Act.
- 1.4 This application form should describe how ‘non-therapeutic’ research protocols with minors meet the conditions set out in Section 71 (3)(b) of the Act of the Act (described below).
- 1.5 All sections of the form must be completed in full.
- 1.6 Ministerial Consent may be granted for non-therapeutic health research with minors when certain conditions set out in Section 71(3) of the Act are met and these conditions are:
 - a) The research objectives cannot be achieved except by the enrolment of minors;
 - b) The research is likely to lead to an improved scientific understanding of conditions, or disorders affecting children;
 - c) Any consent give to the research must be in line with public policy; and
 - d) The research does not pose a significant risk to minors, and if there is some risk, the benefit of the research outweighs the risk.

2. INVESTIGATOR’S DETAILS

Name of principal investigator	Mrs Grace Mbangweta Imenda
Title of research protocol	Exploring Foundation Phase learners’ understanding of a healthy environment through conceptual change and collateral learning strategies
Institutional affiliation	University of Zululand
Postal Address	P.O. Box 101604, Meerensee 3901
Physical Address	14 Meerensee Mews 64 Krewelkring Street, Meerensee 3901
Email Address	graceimenda@yahoo.com
Date of Application	March 13, 2017

Signature of Application

3. APPLICATION

3.1 **Condition 1: The research objectives cannot be achieved except by the participation of minors**

Describe the scientific justification for the enrolment of minors. Explain why this research must be done with minors as participants:

The study seeks to find out Grade 3 learners' understanding of a healthy environment. Furthermore, the study seeks to find out how well Foundation Phase learners can learn selected concepts about the environment. This can only be done among Grade 3 learners.

3.2 **Condition 2: The research is likely lead to an improved scientific understanding of certain conditions, diseases or disorders affecting minors.**

Describe how the research might, or aims to, advance knowledge affecting the health and welfare of minors as a class. Note that 'condition' is defined in the Regulations as 'physical and psycho-social characteristics understood to affect health' allowing that this research does not only involve children with an illness.

Cultivating positive ideas about a healthy environment is very important to start early. Within the school system this should start in the Foundation Phase. The current Foundation Phase curriculum actually starts covering topics about a healthy environment from as early as Grade R. Thus, in carrying out this study at Grade 3 level, the researcher intends to contribute towards the learners' better understanding of the basic concepts that pertain to a healthy environment – including conservation, pollution (water, land, air, noise), recycling, reusing and reducing.

3.3 **Condition 3: Any consent given to the research is in line with public policy**

Consent given by authorized persons must be in line with public policy considerations. Describe how consent to the research will be in line with public policy or would be acceptable, for example, show how the research poses acceptable risks and promotes the rights of minors:

Permission to conduct the research will first be obtained from the Head of the Education Department in the province. Subsequently, within the Education establishment permission will be sought from the relevant school principals, teachers and learners. Quite importantly, because the learners will be minors, the consent of their parents / guardians will be paramount. This, notwithstanding, the learners will be informed of

their right to withdraw from the study at any time should they feel that they cannot continue with the study any further. At an institutional level, I shall ask for permission to do the study from the University's Ethics Committee.

3.4 Condition 4: The research does not pose a significant risk to minors; and if there is some risk, the benefit of the research outweighs the risk.

Describe how the potential risks from the research procedures and/or intervention to minor participants will be minimized and describe any possible benefits from the research to society in the form of knowledge:

The study will be undertaken during school hours and will be based on the official school curriculum. The lessons will be prepared jointly with the class teachers responsible for teaching the Environmental aspects of the curriculum. There is no risk to the learners that can be seen at this point.

ANNEXURE A1: PARTICIPANT INFORMED CONSENT DECLARATION

INFORMED CONSENT DECLARATION

(Participant)

Project Title: Exploring Foundation Phase Learners' Understanding of a Healthy Environment through Conceptual Change and Collateral Learning Strategies

Mrs. Grace Mbangweta Imenda from the Department of Early Childhood Education (ECE) University of Zululand has requested my permission to participate in the above-mentioned research project.

The nature and the purpose of the research project, and of this informed consent declaration have been explained to me in a language that I understand.

I am aware that:

1. The purpose of the research project is to explore Foundation Phase learners' understanding of a healthy environment through conceptual change and collateral learning strategies
2. The University of Zululand has given ethical clearance to this research project and I have seen/ may request to see the clearance certificate.
3. By participating in this research project I will be contributing towards understanding a healthy environment and make appropriate decision which will be good for our Planet Earth.
4. I will participate in the project by learning about a healthy environment, take part in focus group interviews and take a test on the topic.
5. My participation is entirely voluntary and should I at any stage wish to withdraw from participating further, I may do so without any negative consequences.
6. I will not be compensated for participating in the research, but should I incur out-of-pocket expenses they will be reimbursed.
7. There may be risks associated with my participation in the project. I am aware that
 - a. the following risks are associated with my participation: there are no known risks at the moment
 - b. the following steps have been taken to prevent the risks: N/A
 - c. there is a 0 % chance of the risk materialising: N/A
8. The researcher intends publishing the research results in the form of an article. However, confidentiality and anonymity of records will be maintained and that my name and identity will not be revealed to anyone who has not been involved in the conduct of the research.
9. I will receive feedback in the form of marks regarding the results obtained during the study.

10. Any further questions that I might have concerning the research or my participation will be answered by Mrs Grace Mbangweta Imenda (0849031884; 0723686068; 0789030466)
11. By signing this informed consent declaration I am not waiving any legal claims, rights or remedies.
12. A copy of this informed consent declaration will be given to me, and the original will be kept on record.

I, have read the above information / confirm that the above information has been explained to me in a language that I understand and I am aware of this document's contents. I have asked all questions that I wished to ask and these have been answered to my satisfaction. I fully understand what is expected of me during the research.

I have not been pressurised in any way and I voluntarily agree to participate in the above-mentioned project.

.....

.....

Participant's signature

Date

ANNEXURE A2: INCWADI EVEZA IGUNYA LOKUBAMBA IQHAZA

ISIVUMO SOKUZIBOPHEZELA

(Ozophendula)

ISIHLOKO SOCWANINGO: Ingane yamabanga aphantsi efuna ukuzitholela khona ngokwayo ngokuqonda ngezimpilo nolwazi lapha ingane ezithola ikhona ngoshintsho lwezindlela zokufunda ezingaphandle kokuba sesikoleni.

U Mrs Grace Mbangweta Imenda ovela emnyangweni wezemfundo zikahulumeni omkhulu, e Nyuvesi yakwaZulu (oNgoye) uyicele kimi imvume yokungibandakanya kulolu cwaningo mayelana nesihloko esibhalwe ngenhla.

Inhloso ngendlela yokusebenza kwalolu cwaningo ichaziwe kimi ngolimi engiluzwayo futhi ngiyayiqonda.

Ngियाqonda ukuthi:

1. Inhloso yalolu cwaningo ukuthola imibono yabafundi ngokwenza baphumelele empilweni bakwazi ukumela izimo ezinzima.
2. iNyuvesi ilikhiphile igunya ngokusemthethweni lokuthi kwenziwe lolucwaningo futhi ngingayicela ukuyibona noma inini.
3. Ngokubamba iqhaza kulolu cwaningo ngizoba yingxenye yokwakhiwa kwemigomo engasiza noma ezosiza abantu abaningi.
4. Ngizobamba iqhaza ngokuphendula le mibuzo enikeziwe kimi ngokuthembeka.
5. Ukubamba kwami iqhaza kungukuzikhethela futhi nginganquma ukuhoxa noma nini futhi ngeke kungibangele izinkinga.
6. Akukho inzuzo noma isinxephezelo engizosithola ngokuba yinxenye yalolu cwaningo.
7. Ngियाqonda ukuthi buncane ubucayi obungalindeleka kulolu cwaningo. Umcwaningi ungiqinisekisile ukuthi imininingwane iyogodlwa ukuvikela mina uma kasatshalaliswa ulwazi kwabanye. Ngakho ngiyazi ukuthi mginalo ilungelo lokungayiphenduli eminye noma yonke imibuzo futhi nginalo ilungelo lokuhoxa phakathi nokuphendula le mibuzo.
8. Umcwaningi unenhloso yokubhala nokukhipha imiphumela yalolucwaningo kodwa imininingwane eveza ubumina okubhaliwe kuyo negama lami ngeke ivewe komunye umuntu ongesiyo ingxenye yalo msebenzi.
9. Imiphumela ngeke ithunyelwe kimi kodwa ngingayicela ngiyibone.
10. Imibuzo engingaba nayo noma izinkinga ngingaziqondisa ku Mrs Grace Mbangweta Imenda.

Inombolo yocingo: (0849031884; 0723686068; 0789030466)

Isikhahlamezi:

11. Ngokusayina leli phepha elingukuzibophezela angimisi amalungelo ami futhi angibheke kubophezeleka ngokomthetho.
12. Leli phepha liyonikezelwa kimi bese elinye ligcinwe emiqulwini yomcwaningi.

Mina.....ngilifundile lolu lwazi olungenhla futhi ngiyaqinisekisa ukuthi luchaziwe kimi nakho konke okuqukethwe yilawa maphepha. Ngiyibuzile yonke imibuzo ebenginayo futhi yaphendulwa ngokweneliseka. Ngikuqonda konke okulindeleke kimi ngesikhathi kuqhubeka ucwaningo.

Ngiyaqinisekisa ukuthi akunangcindezi engifakwe yona futhi ngingena ngokuzikhethela ekubambeni iqhaza kulolu cwaningo.

Sayina lapha (ozophendula)

Usuku

ANNEXURE B: RESEARCHER'S DECLARATION

I, Grace Mbangweta Imendadeclare that:

- I explained the information in this document to
.....
- requested him/her to ask questions if anything was unclear and I have answered them as best I can
- I am satisfied that s/he sufficiently understands all aspects of the research so as to make an informed decision on whether or not to participate.
- The conversation took place in isiZulu / English
- I used/did not use an interpreter

.....
Researcher's signature

.....
Date

ANNEXURE C: INTERPRETER'S DECLARATION

I,declare that:

- I assisted Mrs Grace Mbangweta Imenda (**name of researcher**) to explain the information in this document to

..... (**name of participant, parent or guardian**)

- The languages I used were English / isiZulu/ Other
- I conveyed an accurate version of what was related to me
- I am satisfied that s/he sufficiently understands all aspects of the research and the content of this document so as to make an informed decision on whether or not to participate.

.....
Interpreter's signature

.....
Date

**ANNEXURE D1: PARENT AND GUARDIAN'S INFORMED CONSENT
DECLARATION**

INFORMED CONSENT DECLARATION

(Parent or Guardian)

Project Title: Exploring Foundation Phase Learners' Understanding of a Healthy Environment through Conceptual Change and Collateral Learning Strategies

Mrs. Grace Mbangweta Imenda from the Department of Early Childhood Education (ECE), University of Zululand has requested my permission to participate in the above-mentioned research project.

The nature and the purpose of the research project, and of this informed consent declaration have been explained to me in a language that I understand.

I am aware that:

1. The purpose of the research project is to explore Foundation Phase learners' understanding of a healthy environment through conceptual change and collateral learning strategies
2. The University of Zululand has given ethical clearance to this research project and I have seen/ may request to see the clearance certificate.
3. By participating in this research project my child/ward will be contributing towards my child's understanding the healthy environment, which may in turn assist him/her make decisions which will be friendly to our environment.
4. My child/ward will participate in the project through focus group interview, tests and learning about a healthy environment.
5. My child's/ward's participation is entirely voluntary and if my child/ward is older than seven (7) years, s/he must also agree to participate.
6. Should I or my child/ward at any stage wish to withdraw my child/ward from participating further, we may do so without any negative consequences.
7. My child/ward may be asked to withdraw from the research before it has finished if the researcher or any other appropriate person feels it is in my child's/ward's best interests, or if my child/ward does not follow instructions.
8. Neither my child/ward nor I will be compensated for participating in the research.

9. There may be risks associated with my child's/ward's participation in the project. I am aware that
 - a. the following risks are associated with my participation: there are no known risks at the moment
 - b. the following steps have been taken to prevent the risks: N/A
 - c. there is a 0 % chance of the risk materialising: N/A
10. The researcher intends publishing the research results in the form of an article. However, confidentiality and anonymity of records will be maintained and that my or my child's/ward's name and identity will not be revealed to anyone who has not been involved in the conduct of the research.
11. I will not receive feedback/will receive feedback in the form of marks regarding the results obtained during the study.
12. Any further questions that I might have concerning the research or my participation will be answered by Mrs Grace Mbangweta Imenda (0849031884; 0723686068; 0789030466)
13. By signing this informed consent declaration I am not waiving any legal claims, rights or remedies that I or my child/ward may have.
14. A copy of this informed consent declaration will be given to me, and the original will be kept on record.

I, have read the above information / confirm that the above information has been explained to me in a language that I understand and I am aware of this document's contents. I have asked all questions that I wished to ask and these have been answered to my satisfaction. I fully understand what is expected of my child/ward during the research.

I have not been pressurised in any way to let my child/ward take part. By signing below, I voluntarily agree that my child/ward....., who is years old, may participate in the above-mentioned research project.

.....

Parent/Guardian's signature

Date

ANNEXURE D2: INCWADI EVEZA IGUNYA LOMZALI UKUTHI UMNTWANA ABAMBE IQHAZA (Umzali noma onegunya lokunakekela umntwana)

1. **Isihloko:** Ingane yamabanga aphantsi efuna ukuzitholela khona ngokwayo ngokuqonda ngezimpilo nolwazi lapha ingane ezithola ikhona ngoshintsho lwezindlela zokufunda ezingaphandle kokuba sesikoleni.

Mrs Grace Mbangweta Imenda osophikweni lwe Early Childhood Education (ECE) enyuvesi yakwaZulu (Ongoye) ucela imvume yami ukuhlanganyela ocwaningweni lwakhe olukusihloko esingenhla.

Inqubo nomgomo walolu cwaningo, nalesi sivumelwano luchazwe ngolimi engilwaziyo.

Ngiyaqonda ukuthi:

2. **Inhloso yalolucwaningo:** Ingane yamabanga aphantsi efuna ukuzitholela khona ngokwayo ngokuqonda ngezimpilo nolwazi lapha ingane ezithola ikhona ngoshintsho lwezindlela zokufunda ezingaphandle kokuba sesikoleni.
2. I University of Zululand iluvumele lolucwaningo.
3. Ngokuzibandakanya nalolu cwaningo umntwana wami angasiza ekwenzeni ngcono le ndlela yokufundisa ngoku 'hlolelwa kokufunda' lapho kunesidingo sokuba umfundi anikezwe ithuba lokuveza, aziswe ngokufunda kwakhe, kwenye ingxenye uthisha aqhubeke ahlole imisebenzi yabafundi, anyakazise nezindlela zokwenza ukuze ahlangebazane nezidingo zabo.
4. Umntwana wami uzozibandakanya kulolu cwaningo ngokuphendula imibuzo bebhekene, imibuzo esephepheni nano kuhlowa okungatheni.
5. Umntwana wami uzivumele yena ukuba ingxenye yalolu cwaningo futhi uneminyaka engaphezu kweyisikhombisa.
6. Uma mina noma umntwana wami engasathandi ukuba ingxenye yalo, uyohoxa engalandelwa zinkinga ngokuhoxa kwakhe.
7. Umntwana wami angacelwa ukuthi ahoxe ngaphambi kokuphela kocwaningo uma umcwaningi noma ubani omunye ophathelene nalo ebona kufanele noma engalandeli imigomo yalo.
8. Mina nomntwana wami asilindele muholo/mhlomulo ngokuba yingxenye yalolu cwaningo.

9. Angilindele bungozi obungahambisana nalolu cwaningo, akesebheke ukuthi kokulandelayo kungenzeka yini:
 - a) ingozi ehlobene nokuhlanganyela kwakhe? –**Ayikho ingozi eyaziwayo engenzeka ngalesi sikhathi.**
 - b) izinyathelo ezothathwa uma kungenzeka kube nobungozi - **Azikho (ngoba imibuzo yodwa).**
 - c) kukhona ingozi engu 0% engenzeka ngalesi sikhathi - **Ayikho**
10. Umchwani ngi ufisa ukulushicilela lolu cwaningo lube umqingo wencwadi eqikelela ukuthi igama lomntwana wami, nemi niningwane yakhe kuyohlala kuyimfihlo.
11. Ngingathanda/ngingethande ukuzwa ngemiphumela yocwaningo ngokufunda lowo mqingo ozoyoshicilelwa.
12. Imibuzo engingaba nayo mayelana nalolu cwaningo iyophendulwa umchwani ngi uqobo ogama lakhe ngu Mrs Grace Mbangweta Imenda ku 084 9031884; 0789030466; 0723686068).
13. Ngokuzinikela kwami ekusayineni leli fomu angizibophezeli ekutheni ngingethathe izinyathelo okungaba ezomthetho noma ukunxeshelwa komntwana wami.
14. Ngizogcina ikhophi yaleli fomu lokuzibophezela bese lona ligcinwe nguye umchwani ngi.

Mina..... ngiyifundile yonke imininigwane ekuleli fomu futhi ngichazelwe yona ngolimi engilulwaziyo. Ngiyakwazi okubhalwe kuleli fomu. Ngibuze yonke imibuzo ebengingaba nayo ngaphenduleka ngendlela engenelisayo. Ngiyazi konke okulindeleke kumntwana wami ngesikhathi salolu mcwaningo.

Angifakwanga ingcindezi, ngizingenele mina ngokuthanda kulolu cwaningo. Ngokusayina ngiyazivumela mina ukuthi umntwana wami u oneminyaka engu.....angazibandakanya nalolucwaningo.

Isiginesha.....

Usuku.....

ANNEXURE E1: TOPICS TO BE COVERED IN THE INSTRUCTIONAL INTERVENTION

5. Healthy Environment
 - The importance of a clean environment
 - Ways in which people pollute the environment
 - The importance of recycling
6. Water
 - Uses of water - home and school
 - Ways water is wasted
 - Ways of saving water
 - Safe and unsafe drinking water
 - Storing clean water
7. Recycling
 - What happens to our waste
 - Re-using (things that can be used again)
 - Recycling (used things that can be made into something new)
 - Reducing (using less)
 - What cannot be recycled
 - Recycling at home and at school
 - Making compost out of things that rot
 - Re-using water
8. Pollution
 - What pollution is
 - Different types of pollution - water, land, air, noise
 - Effects of pollution on people
 - Effects of pollution on the environment

UMQULU E2: IZIHLOKO OKUMELE ZENZIWE EKUNGEN... KO KU FUNDISWA

1. Inhlanzeko endaweni okuhlalwa kuyo
 - Ukubaluleka kakuhlanzeka kwe mvelo
 - Izindlela abantu abangcolisa ngazo imvelo
 - Ukubaluleka ko kusebenzisa osekusebenzile
2. Amanzi
 - Ukusetshenziswa kwamanzi – ekhaya nasesikoleni
 - Izindlela amanzi amosheka ngazo / Inzindlela zokumosha amanzi
 - Izindlela zokonga amanzi
 - Ukuphepha nokungaphephi kokuphuza amanzi
 - Ukugcina amanzi ehlanzekile
3. Ukusebenzisa okusebenzile
 - Kwenzakalani kwi mfucuza yethu
 - Ukusebenzisa osekusebenzile futhi
 - Ukusebenzisa into eyenziwe ibe into entsha
 - Nciphisa
 - Yini engeke isasebenziswa kabusha
 - Okusetshenziswa emakhaya nasezikoleni
 - Ukwenza isivundiso ngezinto ezibolile
 - Ukusetshenziswa kabusha kwa manzi
4. Ukungcola
 - Yini ukungcola
 - Izinhlobonhlobo ezahlukeno zokungcola – amanzi, umhlabathi, umoya, umsindo
 - Umthelela wokungcola kubantu
 - Umthelela wokungcola kwi mvelo / emvelweni

ANNEXURE F1: TEST ON HEALTHY ENVIRONMENT

Introduction

I am a student pursuing my doctoral studies at the University of Zululand, under the supervision and guidance of Dr. R.P. Pillay and Dr. S.C. Xulu, Faculty of Education. This test is designed to collect information on your understanding about the topic: Healthy Environment and other concepts which are related to a healthy environment. This test has two sections: Sections A and B. Please, answer questions in both sections and feel free to say whatever you want to say without fear. The researcher is interested in anything that you may wish to say. There is no penalty even if your answer is not correct.

Thank you for your cooperation in advance!

SECTION A: BIOGRAPHICAL INFORMATION

Please, answer the following questions by writing your answer in the spaces provided.

- 1. Your Age
- 2. What is your gender? Female..... Male.....
- 3. Home language:

SECTION B:

- 1. What do you understand by the following terms:
 - 1.1. Environment?
.....
 - 1.2. Pollution?
.....
 - 1.3. Safe drinking water?
.....
 - 1.4. Unsafe drinking water?
.....

1.5. Wasting water?

.....

1.6. Using water wisely (Conserving water)?

.....

1.7. Recycling?

.....

1.8. Re-using scarce natural resources?

.....

1.9. Reducing (in the context of conserving scarce natural resources)?

.....

2. What are the different types of pollution which you know?

.....

3. How does pollution affect people?

.....

4. How does pollution affect the environment?

.....

UMQULU F2: UHLOLO NGEMVELO EHLAZEKILE

Isingeniso

Lesi sivivinyo sakhelwe ukuqoqa ulwazi lwakho ngokuqonda lezi zihloko: Imvelo ehlanzekile nezinye izingxenye eziphathelele nemvelo ehlanzekile. Lesi sivivinyo sinezingxenye ezimbili: Ingenxe A no B. Ngicela uphendule imbuzo kuzo zonke izingxenye futhi uzizwe ukhululekile ukusho noma yini ofuna ukuyisho ngaphandle kokusaba. Umcwaningi ulangazelele noma yini ofisa ukuyisho . Akukho nhlawulo / sijeziro ngisho noma impendulo ingeyiyo / ingaqondile / ingashayi emhlohlweni.

Nginyabonga ngokuzibophezela kwakho phambili.

INGXANYE A: ULWAZI LWEMVELAPHI

Ngicela uphendule lemibuzo elandelayo ngokuthi ubhale izimpendulo zakho ezikhaleni ezinikeziwe.

1. Iminyaka yakho:
2. Yini ubulili bakho? Umfana..... Intombazana.....
3. Ulimi lwasekhaya:

INGXENYE B:

1. Yini oyiqondakho ngalamagama alandelayo:
 - 1.1. Imvelo?
.....
 - 1.2. Ukungcola?
.....
 - 1.3. Ukuphuza amanzi aphephile?
.....
 - 1.4. Ukuphuza amanzi angaphephile?

1.5. Ukumosha amanzi?

.....

1.6. Ukusebenzisa amanzi ngendlela eyiyo (Ukugcina amanzi)?

.....

1.7. Ukusebenzisa osekusebenzile?

.....

1.8. Ukusebenzisa okushodayo okuyimvelo?

.....

1.9. Nciphisa ukusebenzisa imvelo / Gcina imvelo ingapheli?

.....

2. Yiziphi izinhlobo ezahlukene zokungcola ozaziyo?

.....

3. Ukungcola kubaphazamisa kunjani abantu?

.....

4. Ukungcola kuyiphamisa kunjani imvelo?

.....

**ANNEXURE G1: INTERVIEW SCHEDULE – REASONS BEHIND LEARNERS’
ANSWERS**

Introduction

I am a student pursuing my doctoral studies at the University of Zululand, under the supervision and guidance of Dr. R.P. Pillay and Dr. S.C. Xulu, Faculty of Education. This interview schedule is designed to collect information to help me understand the reasons behind your answers. So, you are asked to look closely at some pictures and explain what you think the pictures are telling you. Please, feel free to say whatever comes to your mind without fear. The researcher is interested in anything that you may wish to say. There is no penalty even if your answer is not correct.

Thank you for your cooperation in advance!

SECTION A: BIOGRAPHICAL INFORMATION

Please, answer the following questions by writing your answers in the spaces provided.

1. Your Age
2. What is your gender? Female..... Male.....
3. Home language:

SECTION B: A HEALTHY ENVIRONMENT

Instructions

Look closely at each picture and explain what you think the picture is telling you about the environment.

1. Picture 1



2. Picture 2



3. Picture 3



4. Picture 4



5. Picture 5



6. Picture 6



7. Picture 7



8. Picture 8



UMQULU G2: IZIZATHU EZIHAMBISANA NEZIMPENDULO ZABAFUNDI

Isingeniso

Ngingumfundi owenza izifundo zobu dokotela enyuvesi ya kwa Zulu, ngaphansi komsizi nomgadi Dokotela R.P. Pillay Kanye no Dokotela S.C. Xulu, emkhakheni wezemfundo. Lenhlolo hlelo yenzelwe ukuqoqa ulwazi oluzongisiza ukuqonda izizathu ngemuva kwezimpendulo zakho. Lenhlolo hlelo yenzekile ukuqoqa ulwazi oluzongisiza ukuqonda izizathu ngemuva kwezimpendulo zakho. Nje, wena uyabuzwa ukuba ubuke eduze / ubuke usondele / ubuka khahle izithombe futhi uchaze ukuthi ucabanga ukuthi isithombe sikutshelani. Ngicela uzizwe ukhululekile ukusho noma yini efika emqondweni wakho ngaphandle kokwesaba. Umcwaningi /Umqoqi wolwazi ulangazelele ukuzwa noma yini ongafisa ukuyisho. Akukho sijeziro / nhlawulo ngisho ngabe uma impendulo ingeyiyo / ingeyona.

Ngiyabonga ngokuzibophezela kwakho phambili.

INGXANYE A: ULWAZI LWEMVELOPHI

Ngicela uphendule lemibuzo elandelayo ngokuthi ubhale izimpendulo zakho ezikhaleni ezinikeziwe.

1. Iminyaka yakho:
2. Yini ubulili bakho? Umfana..... Intombazana.....
3. Ulimi lwasekhaya:

INGXENYE B: INHLANZI KO ENDAWENI OKUHLALWA KUYO

Imigomo

Buka kahle isithombe ngasinye futhi uchaze ukuthi ucabanga ukuthi isithombe sikhuluma ngani mayelana nezemvelo.

1. Isithombe sokuqala



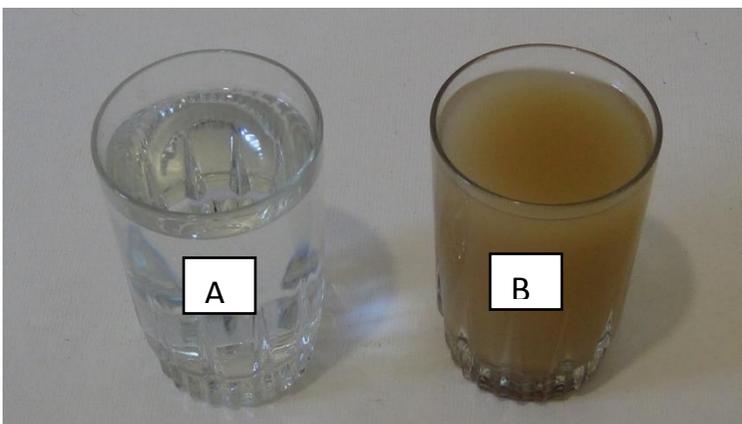
2. Isithombe sesibili



3. Isithombe sesithathu



4. Isithombe sesine



5. Isithombe sesihlanu



6. Isithombe sesithupha



7. Isithombe sesikhombisa



8. Isithombe sesishiyagalombili



**ANNEXURE H: APPLICATION FOR PERMISSION TO CONDUCT RESEARCH IN
KWAZULU NATAL DEPARTMENT OF EDUCATION INSTITUTIONS.**



kzn education
Department:
Education
KWAZULU-NATAL

**Application for Permission to Conduct Research in
KwaZulu Natal Department of Education Institutions**

1. Applicants Details

Title: Mrs Surname: Imenda

Name(s) Of Applicant(s): Grace Mbangweta Email: graceimenda@yahoo.com

Tel No: 035-7535050 Fax: N/A Cell: 0849031884; 0789030466; 0723686068

Postal Address: P.O. Box 101604, Meerensee 3901.

Proposed Research Title: Exploring Foundation Phase Learners' Understanding of a Healthy Environment through Conceptual Change and Collateral Learning Strategies

2. Have you applied for permission to conduct this research or any other research within the KZNDoE institutions? No

Yes

✓ No

If "yes", please state reference Number: N/A

3. Is the proposed research part of a tertiary qualification? Yes

Yes

No

If "yes"

Name of tertiary institution: University of Zululand

Faculty and or School: Faculty of Education

Qualification: Doctor of Education / D.Ed. **Course Code:** EDU 800

Name of Supervisor: Dr. R.P. Pillay **Signature**_____

Co-Supervisor: Dr. S.C. Xulu **Signature**_____

If "no", state purpose of research: N/A

4. What is the main research question(s):

4.1 What conceptions do grade three learners have of the construct of a healthy environment?

4.2 What explanations lie behind the learners' conceptions of a healthy environment?

4.3 Will there be a statistically significant difference in learner achievement between those taught through a cognitive conflict-based conceptual change approach versus those taught through an instructional approach based on Collateral Learning Theory?

7 Methodology including sampling procedures and the people to be included in the sample:

Research Paradigm

This study will follow a mixed methods approach, meaning that both qualitative and quantitative data will be collected. The Quantitative and Qualitative research paradigms are the most commonly cited by researchers (Denzin, 1978; Dzurec and Abraham, 1993; Johnson, and Onwuegbuzie, 2004; Guba and Lincoln, 2005, Punch, 2013). However, Schwandt (2000, 2001) has taken issue with these “paradigm wars,” calling into question the need for the divisions, differentiation and the defining through opposition of qualitative (and other) research. In his view, “it is highly questionable whether such a distinction [between qualitative inquiry and quantitative inquiry] is any longer meaningful for helping us understand the purpose and meaning of human inquiry” (2000: 210). Schwandt (2000: 210) also declared the following:

All research is interpretive, and we face a multiplicity of methods that are suitable for different kinds of understandings. So the traditional means of coming to grips with one’s identity as a researcher by aligning oneself with a particular set of methods (or being defined in one’s department as a student of “qualitative” or “quantitative” methods) is no longer very useful. If we are to go forward, we need to get rid of that distinction.

In the wake of Schwandt’s views, there has been a resurgence of the *mixed methods* (blended research paradigm – which Johnson, et al (2007: 113) define as “an approach to knowledge (theory and practice) that attempts to consider multiple viewpoints, perspectives, positions, and standpoints (always including the standpoints of qualitative and quantitative research)”. In a similar vein, Greene (2008: 20) has subsequently defined the ‘mixed methods way of thinking’ “an orientation toward social inquiry that actively invites us to participate in dialogue about multiple ways of seeing and hearing, multiple ways of making sense of the social world, and multiple standpoints on what is important and to be valued and cherished.”

In looking at the research questions that undergird this study, the mixed methods paradigm has been found to be the appropriate research paradigm for the study because the researcher will need to collect both qualitative and quantitative data in order to adequately address the research questions.

Research Design

As a mixed methods research project, there will be two designs applied. The first will be the Case Study design, in order to address the first two research questions. The second research design will be the Non-equivalent Groups quasi-experimental research design. This latter design will be used to address the third research question.

Target Population, Sampling Techniques and Research Sample

This study will be conducted within the King Cetshwayo education district. Altogether, it is envisaged that four schools offering Foundation Phase education will be involved, giving a total of approximately 160 learners, at the average of 40 learners per class. For reasons of accessibility, the study will be confined to the Nseleni, Richards Bay and ESikhaleni schools. Simple random sampling will be used to select the four participating schools from these areas.

Data Collection Procedures

Data collection will involve interviews with learners as well as the use of written tests. In order to maximise on learner participation, focus group interviews will be conducted. This will enable the researcher to interview several groups of learners, giving her a bigger number of participants, than would be possible by holding interviews with individual learners. The written tests will be administered in the usual way as class tests. Permission will be requested to have all the interviews voice-recorded so that the interviewer can focus on the conversations with the learners rather than, for instance, on note-taking.

Data Analysis Approaches and Techniques

Qualitative data arising from the administration of the interview schedule will be based on the hermeneutical approach as it “allows one to focus on the text produced according to the question asked as an expression of the respondents’ personal experiences and accepted values” (Läänemets, et al, 2012: 29). Furthermore, in hermeneutical analysis, information can be analysed at multiple levels and from different points of view. Hermeneutical analysis is interpretative in nature thus, data analysis is reiterative, ongoing, recursive, and dynamic – evolving from the data rather than based on existing or *a priori* notions (Merriam, 1988; Keeney, Keeney and Chenail, 2015). In this study, the first stage of data analysis will involve reading through all the transcripts of the learner responses and creating categories of description to represent emerging themes. This will entail finding patterns from which the themes and conceptual categories can be constructed. In a reiterative process, the recurring themes and conceptual categories will progressively be reduced in number by combining conceptually similar ones, resulting in a consolidated, fewer numbers of categories of descriptions.

Quantitative data will be analysed statistically using an appropriate statistical software package, such as the Statistical Product and Service Solutions (SPSS). The analysis will involve a comparison of the means as a result of the two interventions. In this regard, either the Analysis of Variance (ANOVA) or t-test will be used.

8 What contribution will the proposed study make to the education, health, safety, welfare of the learners and to the education system as a whole?

The challenges of ensuring that learners get the best learning experience at school despite their home or cultural backgrounds is an on-going paradox for most teachers, especially with respect

to science teaching. This is so because most learners and teachers find the content and ways of science to be far removed from their day-to-day experiences. Classroom diversity, which has also become a reality for most classrooms currently, has intensified a search for solutions insofar as dealing with the different world perspectives which learners bring to the classrooms is concerned. Thus, to the extent that this study seeks to find solutions to the challenges of how best to address the knowledge that learners bring to the classroom holds prospects for making a significant contribution to both knowledge and classroom practice. Furthermore, conducting the study at the Foundation Phase level should also give this study added benefits to both teachers and learners. Many attitudes and conceptual orientations are formed early in a child's life so, hopefully, by virtue of participating in this study, the learners concerned will form positive attitudes and scientifically acceptable conceptions about the environment, which is the main topic under investigation in this study.

9. KZN Department of Education Schools or Institutions from which sample will be drawn – If the list is long please attach at the end of the form

10. Research data collection instruments: *(Note: a list and only a brief description is required here - the actual instruments must be attached):*

There will be several research instruments to be used in this study. First, it will be learning materials developed for the two instructional approaches which will be compared, namely the Cognitive-Conflict based approach versus the instructional materials based on the Collateral Learning theory. The second research instrument will be an interview schedule which will seek to explore the grade three learners' understanding of a healthy environment and explore the explanations which lie behind their understanding of a healthy environment. The third research instrument will be the pre-test which will seek to establish the baseline knowledge that the learners have about a healthy environment. The same test will also serve as a post-test to measure the comparative gains that the learners will have made following the two respective interventions.

11. Procedure for obtaining consent of participants and where appropriate parents or guardians:

Permission shall be sought from the Head of Department, KZN, the school principals concerned, participating teachers and the parents of the learners to participate in the study. Sample consents letters are attached.

12. Procedure to maintain confidentiality (if applicable):

The researcher will ensure confidentiality of the respondents' answers, and that such responses are used solely for the purpose of this research. In the whole process, a relationship of trust, integrity and honesty shall be maintained.

13. Questions or issues with the potential to be intrusive, upsetting or incriminating to participants (if applicable): The researcher will inform the participants that they are free to withdraw from the study, at any time, should they feel that the questions being asked have in

any way whatsoever been / are intrusive, upsetting or incriminating with respect to their person or privacy. They will be given the list of questions before the interviews, so that they have the freedom to withdraw even before the interviews commence. In the case of the grade three learners, their parents will also be informed accordingly with regard to the rights of the learners to withdraw from the study at any point should they feel inconvenienced in any way. The interview questions to be asked the learners will be given to their parents / guardians for their approval.

14. Additional support available to participants in the event of disturbance resulting from intrusive questions or issues (if applicable): None. It is not expected that the learners will experience anything different from what they normally experience during normal learning time.

15. Research Timelines :

TASK	SUGGESTED PERIOD	ACTUAL DATES
Research Proposal	September, 2016	
Correction and resubmission of proposal	October, 2016 – February, 2017	
Ethical Clearance	February - March, 2017	
Literature Review	February – May , 2017	
Methodology.	May – June, 2017	
Field Study	July – September, 2017	
Data Analysis and interpretation	September - October, 2017	
Presentation of Results	November 2017	
Submission of First Draft of thesis	January, 2018	
Submission of Final Draft for Examination	March, 2018	
Final Revisions	May, 2018	

16. Declaration

I hereby agree to comply with the relevant ethical conduct to ensure that participants' privacy and the confidentiality of records and other critical information.

I Grace Mbangweta Imenda declare that the above information is true and correct

Signature of Applicant

7 March, 2017 ____

Date

17. Agreement to provide and to grant the KwaZulu Natal Department of Education the right to publish a summary of the report.

I/We agree to provide the KwaZulu Natal Department of Education with a copy of any report or dissertation written on the basis of information gained through the research activities described in this application.

I/We grant the KwaZulu Natal Department of Education the right to publish an edited summary of this report or dissertation using the print or electronic media.

7 March, 2017_____

Signature of Applicant(s)

Date

Return a completed form to:

Nomangisi Ngubane: Nomangisi.ngubane@kzndoe.gov.za

Phindile.Duma@kzndoe.gov.za

The Research Unit; Resource Planning; KwaZulu Natal Department of Education



education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries: Phindile Duma

Tel: 033 392 1041

Ref.:2/4/8/1188

Mrs GM Imenda
PO Box 101604
Meerensee
3901

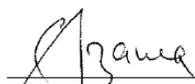
Dear Mrs Imenda

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: “EXPLORING FOUNDATION PHASE LEARNERS’ UNDERSTANDING OF A HEALTHY ENVIRONMENT THROUGH CONCEPTUAL CHANGE AND COLLATERAL LEARNING STRATEGIES”, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the Intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 31 March 2017 to 07 June 2019.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Connie Kehologile at the contact numbers below
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

King Cetshwayo District



Dr. EV Nzama
Head of Department: Education
Date: 03 April 2017

...Championing Quality Education - Creating and Securing a Brighter Future

KWAZULU-NATAL DEPARTMENT OF EDUCATION

Postal Address: Private Bag X9137 • Pietermaritzburg • 3200 • Republic of South Africa

Physical Address: 247 Burger Street • Anton Lembede Building • Pietermaritzburg • 3201

Tel.: +27 33 392 1004/41 • Fax.: +27 033 392 1203 • Email: Kehologile.Conn@kzndoe.gov.za/Phindile.Duma@kzndoe.gov.za • Web: www.kzndoe.gov.za

Facebook: KZNDOE...Twitter: @DBE_KZN...Instagram: kzn_education...Youtube:kzndoe

14 Meerensee Mews
64 Krewelkring Street
P.O. Box 101604
Meerensee 3901
RICHARDS BAY

August 15, 2017

The Principal
Vondlo Primary School
NSELENI

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I am a doctoral student in the Faculty of Education at the University of Zululand, studying under the guidance of Dr. R.P. Pillay and Dr. S.C. Xulu. The title of my research is: Exploring Foundation Phase Learners' Understanding of a Healthy Environment through Conceptual Change and Collateral Learning Strategies, to be undertaken in the King Cetshwayo district of KwaZulu Natal.

I hereby request permission to conduct research in your school. This research involves interviews and tests administration to learners and their educators, aimed at ascertaining their experiences and conceptions about assessment for learning, and its possible impact on learner performance in Life Sciences in your school.

Please find attached copies of the questionnaires and interview questions which I intend using with all the participants. Please feel free to contact me should you have any queries in this regard.

Thank you.

Yours faithfully,



Imenda, GM (Mrs.)

Mobile: 0849031884; 0789030466; 0723686068



EDUCATION
KwaZulu-Natal
15/08/2017

14 Meerensee Mews
64 Krewelkring Street
P.O. Box 101604
Meerensee 3901
RICHARDS BAY

August 15, 2017

The Principal
Bajabulile Primary
ESIKHALENI

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I am a doctoral student in the Faculty of Education at the University of Zululand, studying under the guidance of Dr. R.P. Pillay and Dr. S.C. Xulu. The title of my research is: Exploring Foundation Phase Learners' Understanding of a Healthy Environment through Conceptual Change and Collateral Learning Strategies, to be undertaken in the King Cetshwayo district of KwaZulu Natal.

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Please find attached copies of the questionnaires and interview questions which I intend using with all the participants. Please feel free to contact me should you have any queries in this regard.

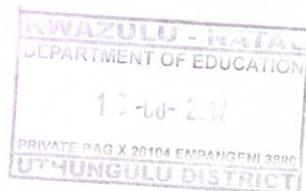
Thank you.

Yours faithfully,



Manda, GM (Mrs.)

Mobile: 0849031884; 0789030466; 0723686068



ANNEXURE L: LETTER TO THE PRINCIPAL OF EACH SCHOOL REQUESTING PERMISSION TO CONDUCT RESEARCH INVOLVING THEIR EDUCATORS AND LEARNERS.

14 Meerensee Mews
64 Krewelkring Street
P.O. Box 101604
Meerensee 3901
RICHARDS BAY

March 9, 2017

The Principal

.....

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I am a doctoral student in the Faculty of Education at the University of Zululand, studying under the guidance of Dr. R.P. Pillay and Dr. S.C. Xulu. The title of my research is: Exploring Foundation Phase Learners' Understanding of a Healthy Environment through Conceptual Change and Collateral Learning Strategies, to be undertaken in the King Cetshwayo district of KwaZulu Natal.

I hereby request permission to conduct research in your school. This research involves interviews and tests administration to learners and their educators, aimed at ascertaining their experiences and conceptions about assessment for learning, and its possible impact on learner performance in Life Sciences in your school.

Please find attached copies of the questionnaires and interview questions which I intend using with all the participants. Please feel free to contact me should you have any queries in this regard.

Thank you.

Yours faithfully,

Imenda, GM (Mrs.)

Mobile: 0849031884; 0789030466; 0723686068

ANNEXURE L: LETTER TO THE TEACHER IN EACH SCHOOL REQUESTING PERMISSION TO PARTICIPATE IN THE RESEARCH.

14 Meerensee Mews
64 Krewelkring Street
P.O. Box 101604
Meerensee 3901
RICHARDS BAY

March 9, 2017

The Teacher

.....

REQUEST FOR PERMISSION TO PARTICIPATE IN THE RESEARCH

I am a doctoral student in the Faculty of Education at the University of Zululand, studying under the guidance of Dr. R.P. Pillay and Dr. S.C. Xulu. My research is on the current assessment practices of the teachers and how they see these practices within the context of ‘Assessment for Learning’ and its impact on learner performance in Life Sciences in King Cetshwayo District.

I hereby request your permission to participate in this study. This research involves interviews and questionnaire administration to teachers, aimed at ascertaining their experiences and conceptions about assessment for learning, and its possible impact on learner performance in Life Sciences in your school.

Please find attached copies of the questionnaires and interview questions which I intend using. Please feel free to contact me should you have any queries in this regard.

Thank you.

Yours faithfully,

Imenda, GM (Mrs.)

Mobile: 0849031884; 0723686068; 0789030466

A HEALTHY ENVIRONMENT

SUPPORT MATERIALS

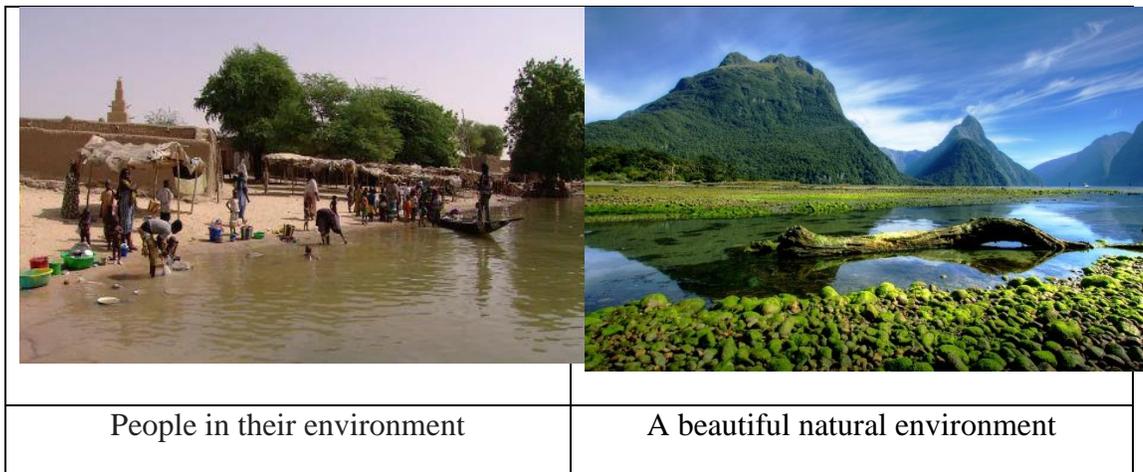
By

Grace Mbangweta Imenda

D.Ed. Student, UNIZULU, August 2017

1. ENVIRONMENT

- The surroundings or conditions in which people, animals and/or plants live.



- Everything that affects people, animals and plants during their lifetime is collectively known as the environment.
- Things which are important to people, animals and plants in the environment are water, air and land
- There are many things which live in water; some live on land, and when we look up we see many things far away – the sun, the moon, stars. All these things are part of our environment.
 - ✓ Science allows us to understand our environment.
 - ✓ Science teaches us to look after our environment so that people, animals and plants can live happily, and for a very long time, on Planet Earth.
 - ✓ There are many things which can destroy the planet.

2. POLLUTION

- Pollution is putting harmful or poisonous substances in water, air or land (soil).

3. DIFFERENT TYPES OF POLLUTION

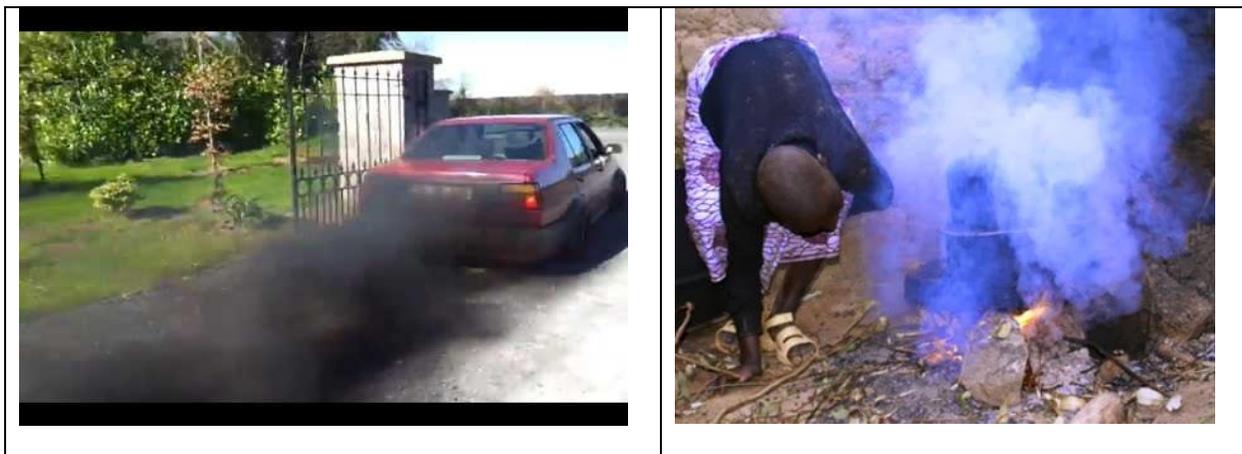
There are several types of pollution, and these are discussed below.

3.1 Air pollution

Smoke or dust in the air is a type of **pollution** as it is bad for the lungs when we breath it in. Air pollution is a result of industrial / factory and home activities which release bad air, smoke and dust into the atmosphere. Industrial actions include burning coal by Eskom to produce electricity. Home actions include cooking using firewood, coal, paraffin, and other fuels which release a lot of bad air into the atmosphere.



- Smoke from home and industrial and vehicular soot - Reduces sunlight and visibility, causes diseases – such as Pneumonia, asthma, and other lung diseases, which cause breathing problems.



Air pollution from car exhaust	Air pollution from cooking
--------------------------------	----------------------------

- The smoke from factories also contains chemicals and gases which cause cancer, and irritations to the human skin and eyes.

	
Skin irritation from air pollution	Eye irritation from air pollution

- Global warming, caused by air pollution, could have significant impacts on human health, agriculture, water resources, forests, wildlife, and coastal areas.

3.2 Water Pollution

Addition or presence of undesirable substances in water is called water pollution. Water pollution is one of the most serious environmental problems. Water pollution is caused by a variety of human activities such as industrial, agricultural and domestic home activities.

Excess fertilizers and pesticides, factory byproducts with toxic substances and sewage water with human and animal wastes pollute our water thoroughly. Natural sources of pollution of water are soil erosion, leaching of minerals from rocks and decaying of organic matter.

	
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Factory polluting water	Raw sewage polluting water
-------------------------	----------------------------

Rivers, lakes, seas, oceans, estuaries and ground water sources may be polluted by factories or people.

Effects on People and the Environment

- Water pollution is the major source of water-borne diseases and other health problems.
- Oil pollution of sea occurs from leakage from ships, oil tankers, rigs and pipelines.
- Accidents of oil tankers spill large quantity of oil in seas which kills marine birds and also affect other sea life and beaches.

Safe and Unsafe Drinking Water

Water pollution means that the water contains some harmful substances which make it dirty, and not safe to drink.



A child holding two bottles of water – one is clean, the other is dirty. The clean bottle of water is safe to drink.



A child drinking dirty water. This could make the child sick.

- The most common cause of death of fish is polluted water. In polluted water, the oxygen content is reduced. So, the fish do not have enough air (oxygen) to breathe – and they die.
- Polluting water can also cause the temperature to rise; the dirty water may also carry some diseases, which may attack the fish – causing death.

Conserving or Saving Water

Conserving, or saving, water means using water wisely so that very little is lost.

- It is very important to save water because it is a scarce resource which can get finished, and then badly affect life.

- Leaking taps and broken pipes cause water to be lost.



Leaking tap – wasting water



Broken water pipe – wasting water



Tap locked to prevent misuse of water



Child keeping tap closed while brushing his teeth. This saves water

3.3 Land / Soil Pollution

- Dumping harmful and poisonous things on land that can damage the soil and make it infertile, so that no crops can grow on it is known as **land** or **soil pollution**. Generally, polluted water also pollutes the land or soil.

A Dumping Site



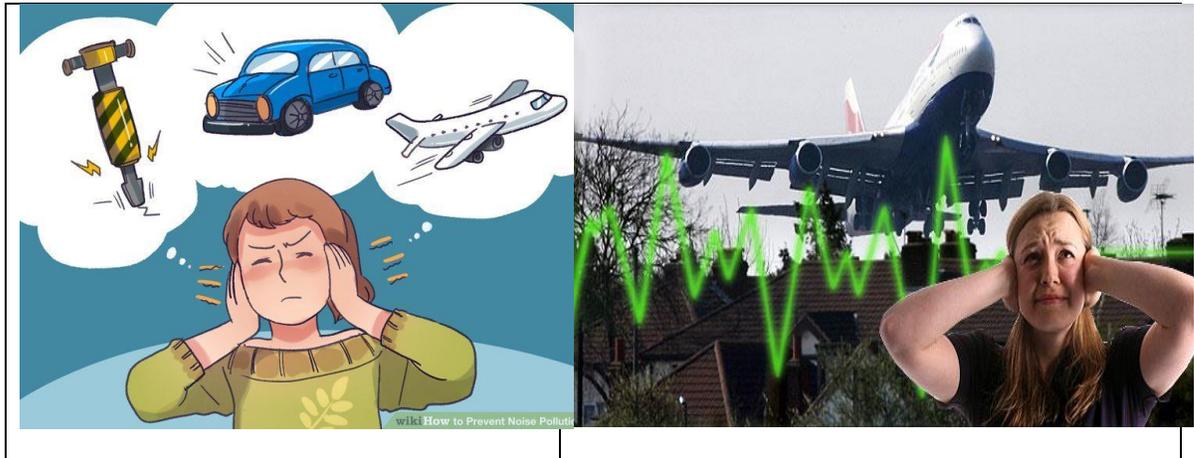
- Plastics, cloth, glass, metals and organic matter (e.g. leftover food), sewage, building debris, generated from households and factories are the main things which pollute our land / soil.
- In addition, fertilizers and pesticides from agricultural use and land filling (i.e. dumping sites) by municipalities also cause land/soil pollution.

Effects of Land/Soil Pollution on People and the Environment

- Dumping harmful or poisonous things on land destroys the environment by making it unable to function as before in terms of agriculture – growing crops, animals grazing, plants (trees, grass, flowers) growing, etc.
- Dumping sites are also sources of diseases, they produce bad smells, are breeding sites for rats, mice and insects which can transmit diseases, and keep away tourists and investors – hence, they are bad for the economy, including employment.
- Many landfills (dumping sites) are always burning and they cause further damage through air pollution
- Harmful and poisonous substances in the soil can end up in the human body directly through the skin, drinking contaminated water, fruits and vegetables Interview should attempt to find out if the learners understand the damage caused to the environment by land pollution.

3.4 Noise Pollution

Noise pollution is a growing problem, mainly through human activities contribute to noise pollution to varying extent. Sources of noise pollution are many and may be located **indoors** or **outdoors**.



Indoor sources include noise produced by radio, television, generators, electric fans, air coolers, air conditioners, different home appliances, and family conflict.

- Noise pollution is more in cities due to a higher concentration of population and industries and activities such as transportation.

Outdoor sources of noise pollution are loudspeakers, industrial activities, automobiles, rail traffic, aeroplanes market / trading activities, religious practices, social and cultural ceremonies (e.g. marriages, funerals), use of fire crackers, sports and political rallies.

Effects of Noise Pollution

- Noise pollution is highly annoying and irritating, especially to people who are working on something.
- Noise disturbs sleep, causes some health disorders / diseases – e.g. hypertension, high stress levels, hearing loss, sleep disturbances, and other harmful effects.

4. PROTECTING THE ENVIRONMENT

- Three most common ways to protect the environment are (a) Reduce (b) Re-Use, and (c) Recycle.



4.1 Reducing

Using less of the resources that could (a) damage the environment (e.g. plastics) and (b) get finished (e.g. water).

<p>Using environmentally friendly shopping bags</p>	<p>Environmentally friendly shopping bags</p>

- By using environmentally friendly shopping bags, people reduce the use of plastics, which spoil the environment.

	
<p>Using dams (water) to produce electricity</p>	<p>Using solar (the sun) and windmills to produce electricity</p>

- South Africa uses coal to produce electricity. Burning coal produces a lot of air pollution, which damages the environment. Instead, using water, solar (the sun) and wind to produce electricity does not harm the environment in any way.
- By using both sides of a sheet of paper people reduce the amount of paper that is needed.

4.2 Re-Using

Finding a new way of using waste material – i.e. material thrown away by the first user.

	
<p>Tires used for a different purpose</p>	<p>Bottles collected to be re-used</p>

In *re-using* the object still remains the same, but it is being used for a different function. On the left, these are still tires, but they are being used as flower pots to decorate a place. The bottle recycling company will clean the bottles and sell them to the various companies which use them for their products. Picking up the bottles leaves the environment clean.

4.3 Recycling

Recycling means using 'waste material' – that is, objects thrown away by other people, in order to make something else which is useful.



In this picture, a woman has collected waste papers to sell to a paper recycling company. This allows the woman to make some money, while cleaning up the environment. The company which buys the waste paper will make different kinds of products – such as toilet paper, exercise books, and other products.



**IMVELO ENEMPILO
INCWAJANA YOKUGCWALISELA
NGU
GRACE MBANGWETA IMENDA
UMFUNDI WE D.ED, UNIZULU, AUGUST 2017**

1. IMVELO

- Imvelo indawo ezungeziwe noma isimo lapho abantu, izilwane kanye nezitshalo kuphila khona.

	
<p>Abantu emvelweni yabo</p>	<p>Ubuhle bemvelo</p>

Yonke into ethinta abantu, izilwane nezitshalo empilweni zibizwa ngokuthi imvelo.

- Izinto ezisemqoka kubantu, kuzilwane nese zitshalweni emvelweni, umoya, amanzi nomhlaba.
- Ziningi izinto eziphila emanzini, ezinye ziphila emhlabeni, uma siphakamisa emehlo, sibona izinto eziningi kude le – ilanga, inyanga nezinkanyezi. Zonke lezi zinto ziyingxenye yemvelo.
 - Isayensi iyasivumela ukuba sazi/siqonde ngemvelo

- Isayensi isifundisa ukuba siyiqaphele imvelo ukuze abantu, izilwane nezitshalo kuzophila kamnandi futhi isikhathi eside emhlabeni.
- Ziningi izinto ezingabulala umhlaba.

2. UKUGCOLISA

- Ukugcolisa kulimaza noma kufaka ubuthi emanzini, emoyeni nase mhlabeni (enhlabathini)

3. IZINHLOBO EZAHLUKENE ZOKUGCOLISA

Kukhona izinhlobo eziningana zokugcolisa ezizodingidwa ngezansi.

3.1 Ukungcoliseka komoya

Intuthu nezintuli emoyeni enye yezindlela **zokugcoliseka** njengoba ihlasela amaphaphu uma siphefumula. Ukugcoliseka komoya kuyimiphumela yezimboni nemisebenzi yase makhaya ezidedela umoya, intuthu nezintuli emkhathini. Imisebenzi yezimboni ihlanganisa kokunye ukushiswa kwamalahle ngu Eskom ukuphehla ugesi. Imisebenzi yasemakhaya ihlanganisa ukupheka kusetshenziswa izinkuni, amalahle, uphalafini nezinye izibhebhezeli ezikhipha inqwaba yomoya omubi zikusa emkhathini.



Ukungcoliseka komoya (intuthu)



Ukungcoliseka komoya (isimokwe)

- Intuthu yasemakhaya neyezimboni nentuthu yezimoto – kwehlisa izinga lokukhanyisa kwelanga, kubange izifo ezinjengo nyumoniya, ufuba nezifo zama phaphu okwenza inkinga ekuphefumuleni.

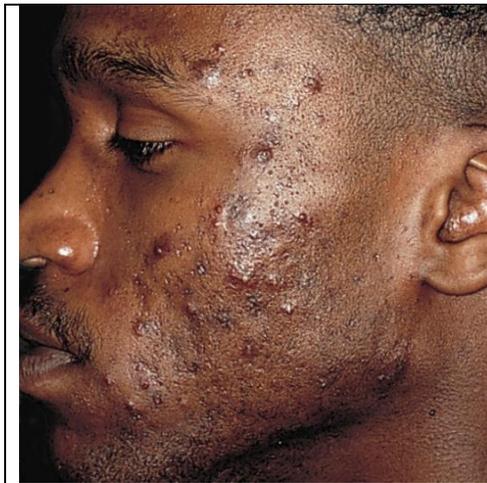


Ukungcoliseka komoya okuvezwa intuthu yemoto



Ukungcoliseka komoya okudalwa ukupheka

- Intuthu yezimboni ithwele amakhemikheli namagesi edala isifo somdlavuza, ukuhlukumezeka kwesikhumba nezinkinga zamehlo.



Ukuhlukumezeka kwesikhumba esidalwa ukungcola komoya



Inkinga yamehlo edalwa ukungcola komoya

- Ukushisa kakhulu komhlaba okudalwa ukungcola komoya, kungaba nomthelela ezimpilweni zabantu, kwezolimo, imithombo yamanzi, emahlathini nase zilwaneni zasendle nase zindaweni ezisogwini.

3.2 Ukungcoliswa kwamanzi

- Ukungeniswa noma ukuba khona nje kwezinto ezingadingekile emanzini kubizwa ngokuthi ukungcoliswa kwamanzi. Ukugcoliswa kwamanzi ingenye yezinto eziyinkinga kakhulu

emvelweni. Ukugcola kwamanzi kwenziwa imisebenzi yabantu enjenge zimboni, izitshalo nemisebenzi yasemakhaya.

- Ubuningi bezikhuthaza khaba noma iziqholo zokubulala izinambuzane ezitshalweni, okuchithwa izimboni okunezinhlanyiya zobuthi kanye nendle yabantu neyezilwane konakalisa amanzi ethu kakhulu. Ngokwemvelo okugcoliseka kwamanzi kudalwa 0 ukuguguleka komhlabathi, ukuphela kwama minerali ematsheni nasezintweni ezifa zibolele entabeni.

	
<p>Izimboni zigcolisa amanzi</p>	<p>Indle nokungcola kungcolisa amanzi</p>

Imifula, amaxhaphozi, ulwandle, imingenela yasolwande, amachibi, amanzi angaphansi komhlaba angangcoliswa izimboni nabantu.

Imiphumela kubantu nase mvelweni

- Ukungcoliseka kwamanzi yiyona siqalo-mbangela esikhulu sezifo ezidalwa amanzi nezinye izingqinamba zempilo.
- Ukungcoliseka ngowoyela olwandle kwenzeka ngokuvuza komkhumbi, ithange lika woyela namapayiphi.
- Ingozi yokuchitheka kakhulu kuka woyela emathangini elwandle ukuthi kubulala izinyoni zolwandle nazo zonke izinto eziphila olwandle nasema bhishi.

Ukuphepha nokungaphephi kokuphuza amanzi

Ukungcoliseka kwamanzi kusho ukuthi amanzi aba nezibhidi ezinobungozi eziwangcolisayo kungabe kusaphepha ukuwaphuza.



Ingane iphethe amabhodlela amabili amanzi - amanye ahlanzekile kanti amanye angcolile. La ahlanzekile iwona aphephile ukuwaphuza



Ingane iphuza amanzi angcolile. Lokhu kungayi gulisa ingane

- Imbangela enkulu yokufa kwezinhlanzi amanzi angcolile. Uma amanzi engcolile ioxigeni iyehla. Lokhu kwenza izinhlanzi zingabi nomoya owanele wokuphefumula - bese ziyafa.
- Ukungcolisa amanzi kwenza ithemperature inyuke, amanzi angcolile angathwala izifo ezingahlasela izinhlanzi - bese ziyafa.

Ukongga/Ukulondoloza amanzi

Ukongga/ukulondoloza amanzi kusho ukusebenzisa amanzi ngokuhlakanipha ukuze abe mancane amosekayo.

- Kusemqoka ukongga amanzi ngoba ayindlala kungenzeka aphele bese kulimala yonke impilo.
- Ukuconsa kompompi kanye nompompi abahlephukile kwenza ukuchitheka amanzi okukhulu.



Umpompi ovuzayo – kumosa amanzi



Ipayipi elihlephukile - limosa amanzi

	
<p>Umpompi okhiyiwe uvimbela ukuchitheka kwamanzi</p>	<p>Ingane ivale umpompi ngesikhathi ixumba amazinyo. Lokhu kongama amanzi</p>

3.3 Ungcoliseka komhlaba/kwenhlabathi

- Ukulahla noma ukuchitha izinto ezinobungozi nobuthi emhlabeni (esigangeni) kungalimaza inhlabathi kuyenze ingabe isaba nomsoco, izitshalo zingabe zisakhula, lokhu kubizwa ngokuthi **ukungcoliseka komhlaba noma kwenhlabathi**. Ekugcineni, ukungcoliseka kwamanzi kunomthelela ekungcolisekeni komhlaba nenhlabathi.

Indawo yokulahla udoti



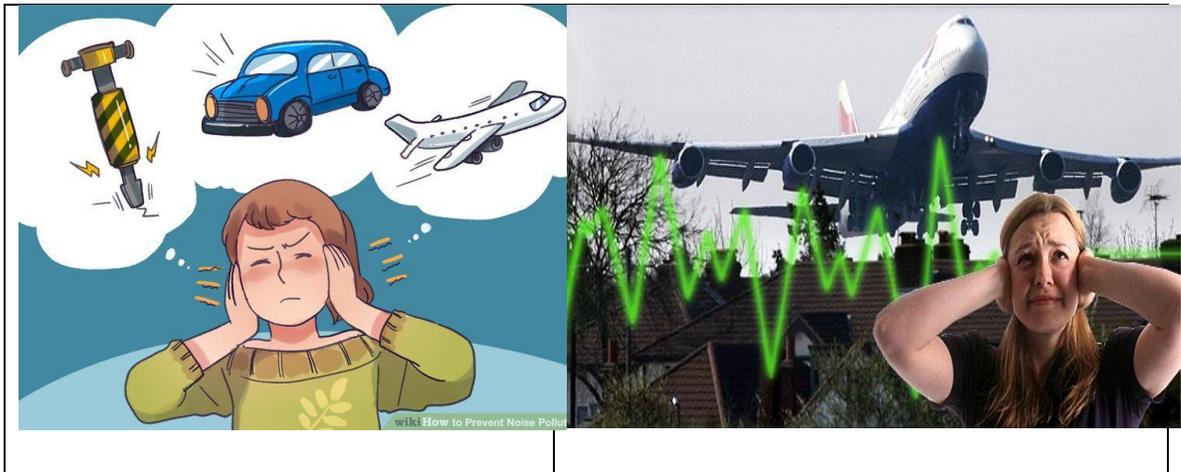
- Amaplastiki, izindwangu, amagilasi, izinkethe nokunye oku-organic (isib: izinsalela zokudla), indle, izinto zokwakha, okukhishwa emakhaya nasezimbonini yizona zinto ezingcolisa umhlaba nenhlabathi.
- Phezu kwalokho, umanyolo nezibulali zinambuzane okusetshenziswa ezilimweni nase kugcwaliseleni (okungaba indawo yokulahla udoti) ngu masipala nakho kuyakwenza ukungcoliseka komhlaba nenhlabathi.

Imiphumela wokugcoliseka komhlaba/mhlabathi kubantu nasemvelweni

- Ukulahla izinto ezinobungozi noma ezinobuthi emhlabathini kubulala imvelo ngokuyenza ingasebenzi njengakuqala ngokwezolimo - ukulima, ukudla kwezinkomo, izitshalo (izihlahla, utshani, izimbali)okukhulayo nokunye okunjalo.
- Lezi zindawo zokulahla ziwumsuka wezifo, ziyanuka, ilapho lonke uhlobo lwamagundwane ezalana ande khona nezinambuzane ezithelelana ngezifo, kuxhosa izivakashi nabatshali zimali – lokhu kunomthelela omubi emnothweni nase mathubeni omsebenzi.
- Eziningi izindawo ezigcwalisiwe (izizinda zokulahla udoti) isikhathi esiningi ziyasha lokho okubanga enye ingozi yokugcoliseka komoya.
- Izinhlayiya ezinobungozi nobuthi enhlabathini zingaphelela emzimbeni womuntu zingena ngesikhumba nangokuphuza lawo manzi anokungcola, nange zithelo nemifino. Imibuzo kumele izame ukuthola kubafundi ukuthi bayaqonda yini ngomonakalo odalwa imvelo ekungcoliseni umhlaba.

3.4 Ukungcoliseka ngomsindo

Ukungcolisa ngomsindo kuyinto ekhulayo kakhulu izinto ezenziwa abantu ziyenezela. Izizinda zomsindo zinhlobonhlobo ziyatholakala **ngaphakathi nangaphandle**.



Umsindo wangaphakathi umbhandakanya umsindo womsakazo, ithelevijini, igeneratha, ifan kagesi, iair cooler, iair conditioner, izinto ezehlukene zikagesi zasekhishini, nokungezwani emndenini.

- Ukungcoliseka ngomsindo kwande kakhulu emadolobheni ngenxa yomthamo wabantu, izimboni nezithuthi.
- Ukungcoliseka ngomsindo okwenzeka ngaphandle kudalwa iloudspeaker, imisebenzi yasezimbonini, izithuthuthu, izitimela, amabhanoyi, izinkonzo, imicimbi (njenge mishado, imingcwabo), okhilikhethi, ezemidlalo nama rali ezezipolitiki.

Imiphumela yokungcoliseka ngomsindo

- Ukungcoliseka ngomsindo kuyacasula kakhulu kubantu abasebenza ngasese.
- Umsindo uphazamisa ukulala, udale nezifo ezinjenge hypertension, ukukhathazeka, ukungezwa, ukuphazamiseka ukulala nokunye nje okungemnandi.

4. UKUVIKELA IMVELO

- Izinto ezintathu ezijwayelekile zokonga imvelo a) ukwehlisa b) ukuphinda usebenzise c) ukujikelezisa



Ukujikeleza

ukunciphisa

phinda usebenzise

4.1 Ukwehlisa

Sebenzisa kancane lokhu okunga a) bulala imvelo (njengama plastiki) ne b) shesha uqede ukusebenza (isib. amanzi).





Ukusebenzisa izikhwama zokuthenga	Izikhwama zokuthenga

- Ngokusebenzisa izikhwama zokuthenga, abantu bayanciphisa ukusebenzisa oplastiki abangcolisa imvelo.

Ukusebenzisa amadamu (amanzi) ukuphehla ugesi	Ukusebenzisa isolar (ngelanga) ne windmill ukuphehla ugesi
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- ESouth Africa sisebenzisa amalahlwe ukuphehla ugesi, kanti ukushisa amalahlwe kwenezela ukungcoliswa komoya owonakalisa imvelo. Ukungcono ukusebenzisa amanzi, isolar (ilanga) nomoya ukukhiqiza ugesi, lokhu akonakalisi imvelo noma nganhloboni.
- Ukusebenzisa amasayidi omabili ephepha abantu bangehlisa inani lephepha elidingekayo.

4.2 Ukuphinda usebenzise

Ukuthola amasu amasha okusebenzisa izinto esezisebenzile – izinto ezilahlwe ngenxa yokuthi bese zisebenzile.

	
Amathaya asetshenziselwa okwhlukile	Amabhodlela aqoqelwe ukuphinda asetshenziswe

Kulendlela siphinda sisebenzisa izinto zinjalo (azishintswa), kodwa sezisetshenziselwa okwhlukile. Ngakwesokunxele, kunamathaya kodwa manje asetshenziswa njengemigodi yokutshala izimbali zokuhlobisa indawo.

Ukuphinda usebenzisa amabhodlela enkampanini bafike bawahlanze bawadayisele ezinye izinkampani ukuba bazisebenzise ngendlela yazo. Ukucosha amabhodlela kwenza indawo ihlanzeke.

4.3 Ukujikeleza

Ukujikeleza kusho ukusebenzisa “izinto ezilahliwe” – sisho izinto ezilahlwe ngabantu, bese senza izinto ezingaba usizo.

	
<p>Ukujikelezisa amaphepha alahliwe</p>	<p>Imikhiqizo ejikelezisiwe</p>

Kulesi sithombe unkosikazi uqoqe amaphepha alahliwe ukuyowadayisa ezinkampanini ezijikelezisayo. Lo nkosikazi uzothola imali ngalokhu, kwenye ingxenye imvelo izobe ihlanzekile. Inkampani ethenga lama phepha izokwenza ezinye izinhobo zemikhiqizo – njengephepha lase ndlini yangasese, izincwadi zokubhalela abafundi nokunye okuningi.

	
<p>Imikhiqizo ejikelezayo – ikepisi nesikhwama</p>	<p>Isikhwama</p>

ANNEXURE L



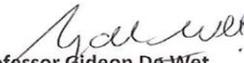
ETHICAL CLEARANCE CERTIFICATE

Certificate Number	UZREC 171110-030 PGD 2017/163					
Project Title	Exploring Foundation Phase Learners' Understanding of a Healthy Environment through Conceptual Change and Collateral Learning Theories					
Principal Researcher/ Investigator	GM Imenda					
Supervisor and Co-supervisor	Dr RP Pillay			Dr SC Xulu		
Department	Early Childhood Education					
Faculty	Education					
Type of Risk	High – Data collection from people					
Nature of Project	Honours/4 th Year		Master's		Doctoral	x Departmental

The University of Zululand's Research Ethics Committee (UZREC) hereby gives ethical approval in respect of the undertakings contained in the above-mentioned project. The Researcher may therefore commence with data collection as from the date of this Certificate, using the certificate number indicated above.

- Special conditions:
- (1) This certificate is valid for 3 years from the date of issue.
 - (2) Principal researcher must provide an annual report to the UZREC in the prescribed format [due date-30 April 2018]
 - (3) Principal researcher must submit a report at the end of project in respect of ethical compliance.
 - (4) The UZREC must be informed immediately of any material change in the conditions or undertakings mentioned in the documents that were presented to the meeting.

The UZREC wishes the researcher well in conducting research.


Professor Gideon De Wet
Chairperson: University Research Ethics Committee
Deputy Vice-Chancellor: Research & Innovation
11 April 2017

CHAIRPERSON
UNIVERSITY OF ZULULAND RESEARCH
ETHICS COMMITTEE (UZREC)
REG NO: UZREC 171110-30
11-04-2017
RESEARCH & INNOVATION OFFICE